Features and benefits

Ergonomic

FinnFin foot pockets provide exceptional ergonomics, as they are **custom-made** to match the individual 3D-shapes of divers' left and right foot. This allow making foot pockets that can be worn for hours and does not cause painful pressure points, and removes the need to use soft (neoprene) diving socks to protect against blisters.

The carefully selected **materials** used in the foot pocket provide high stiffness where it is needed to improve ergonomics (e.g. the sole of the foot pocket) and compliance where this is needed (e.g. the upper cover of the foot pocket that contacts the soft skin of upper leg).

Divers who have so flexible ankles that they can easily extend them straight down have often difficulties in using efficient diving fins, as kicking with these fins causes the ankles to over-extend into positions that the ankle anatomy is not built for. This over-extension can cause acute pain and even long-lasting injuries in the ankles. FinnFin's **ankle lock** (patent pending) protects against over-extending, and thus helps to avoid pain and injuries.

Efficient

FinnFin's foot pockets provide unrivalled **power transfer efficiency** from the diver's muscles into forward thrust: the foot pocket material (carbon fibre, Kevlar) does not **stretch** like the commonly used rubber before beginning to transfer the power towards the fin blade. Similarly, as the foot pocket fits perfectly to the divers' feet, the foot does not **shake** inside the foot pocket and there is no need for a soft diving sock that would **squeeze** in each kick and cause yet more power transfer losses.

FinnFin diving fin system is causes low drag by being highly **hydrodynamic**. The foot pockets have customized **angles** built into them that orient the fin blade to be parallel with the diver's direction of movement. These angles are customized for each leg separately to account for the possible flexibility differences between left and right ankles. Without these corrective angles, the diver's knees would bend in the glide phase between kicks, thus increasing hydrodynamic drag. These angles are made with highly pressure-resistant, yet **buoyant** material that prevent the fins from sinking and thus increasing hydrodynamic drag even when having long gliding breaks between the kicks. Finally, the fin blades are shaped using the same **geometries** of nature's best divers, orcas and sperm whales, which allows leveraging the millions of years' of evolution that has optimized these animals into the apex predators in their domains.

FinnFin diving fin system allows the diver to produce thrust also from an **efficient up/back-kick**. Typically, divers produce most of their thrust only in the down/front-kick, even though the human body would have large muscle groups (hamstring, glutes, lower back) available for producing power also in up/back-kick. This inefficiency is caused by ankle pivoting unnecessarily in up/back-kick, before these back-muscles' power could be transferred into the fin blade. Normally, the ankle can be prevented from pivoting by a large effort from the calf muscle to keep the fin blade extended, but this is extremely inefficient as the diver needs to use one set of own muscles (calf) to fight against another set of own muscles (hamstring, glutes, lower back). Additionally, high efforts from calf muscle can cause dangerous cramps. In practice this inefficiency causes most divers to ignore the up/back kick, which can be seen as a straight, unbent fin blade during up/back-kick. FinnFin diving fin system provides two remedies to this problem: firstly, the very **stiff foot pocket sole** (e.g. carbon fibre) greatly improves the leverage and efficiency that the diver has when using calf muscles to keep the ankle extended. Biggest remedy is still the **ankle lock** (patent pending), which, when used, completely removes the need to do any work with calf muscles in order to keep the ankle extended. The diver can then proceed to use this up/back-kick efficiency as increased speed or lower O2-consumption as the work is more evenly distributed across large muscle groups.

The diving **fin blade** needs to perform multiple different tasks well to be efficient:

- In the **kick phase** the fin needs to quickly bend into an efficient angle of attack (~45degrees) in order to move water backwards, then sustain this angle when the kick force increases. Furthermore, the moved water needs to be guided to maximize the generated forward thrust, instead of wasting it to inefficient directions (left, right, up, down). FinnFin fin blades are custom-laminated carbon fibre that are made to each individual diver's needs and orders. This allows making fins that have soft end, so that even a relaxed kick will begin to bend the fin to the efficient angle, and then progressively increasing stiffness towards the foot pocket, so that the fin blade can accommodate a wide range of kicking force. Furthermore, the fin blade is only as long as it needs to be to accommodate the maximum kicking force of the individual diver: any unbent part of the fin blade is extremely inefficient as it only moves water up/down in the kick, i.e. consumes energy but does not generate thrust. Finally, the fin's tail end geometry is shaped according to Nature's best divers (e.g. orcas or sperm whales), which maximizes the thrust output of the water moved by the fin blade.
- In the **end of each kick**, the fin blade needs to efficiently release the energy that has been required to bend it during the kick phase. This efficiency (i.e. hysteresis loss) depends on the materials used in the fin blade. FinnFin fin blades are made of carbon fibre which is the same material that is used also in other high-end applications where low hysteresis loss is desired, like archery. Similarly, no high-performance archery bow is made from the rubber or plastic that are the common materials used in diving fins.
- Finally, in the **gliding phase between kicks**, or during the free-fall phase in free diving, an efficient fin blade needs to minimize the drag that it creates. Again in here, the front- and tail-end geometries of the fin blades use the same shapes as Nature's best divers, e.g. orcas and sperm whales, who depend on their ability to minimize power losses while travelling long distances across or into the ocean.

Weight is the final component in the efficiency of FinnFin diving fin system. The entire system is made using very light, yet strong materials, e.g. carbon fibre and Kevlar to achieve the desired performance and robustness with minimal weight. The low weight is especially important in the fin blade, that has the most angular momentum and where minimal hysteresis loss is required. When a typical simple diving fin that has no advanced features like an angle to orient the fin blade can weight 1400g per fin (not including the needed diving sock), and a competition-level fin with advanced features like angle and buoyancy compensation can weight 1800 – 1900g per fin, **FinnFin** diving fin system weights **~700g per fin** which is comparable to the weight of the most minimalistic fins used in underwater rugby.

Weight comparison				Weight (grams/fin)	Features: Angle compensation	Buoyancy compensation	Interchangeable blade	Fin blade material
Typical current fins	Stereo-/bi-fins	Scuba diving (Scubapro Jetfin)		1400	No	No	No	Rubber
		Spearfishing		1050	No	No	Yes	Glass fibre
		Underwater rugby		540	No	No	No	Glass fibre
		Rescue competition		1940	No	No	No	Glass fibre
	Monofin	High-end competition fin		3600	Yes	Yes	No	Glass fibre
FinnFin fins (*)	Assembly configuration							
	Foot pocket	Ankle lock	Fin blade					
	Carbon/Kevlar	No	Uncoated	650	Yes	Yes	Yes	Carbon fibre
	Carbon	No	Uncoated	750				
	Carbon/Kevlar	Carbon/Kevlar	Uncoated	750				
	Carbon	Carbon	Uncoated	870				
	Carbon	Carbon	Deep gloss	940				
	Weight break-down			Weight (grams / component)				
	Foot pocket		Carbon fibre	570				
			Carbon/Kevlar hybrid	470				
	Ankle lock		Carbon fibre	120				
			Carbon/Kevlar hybrid	100				
	Fin blade		Uncoated	180	(*): FinnFin components' weights vary e.g. according to foot size or needed angle correction			
			Deep gloss coating	250				

The impact of this weight difference can be simulated by adding the corresponding weight difference as extra ankle weights when diving with regular fins, and then removing the weights and continuing diving to identify the difference.

Adjustable

FinnFin Diving fin system has exceptional adjustability, as it allows changing diving fin blades to meet the different needs of individual dives, even by changing a regular stereo/bi-fin blades into a monofin blade. There is no need to buy new set of foot pockets along with each new set of fins, but rather, use the best foot pocket for all dives and attach it into the fin blade that meets the needs of each individual dive. Additionally, FinnFin fins can be used as regular fins for maximal agility, without the ankle lock. Alternatively, fins can be used with the ankle lock for exceptional efficiency in up/back-kick. Or one can use ankle lock in one leg only for balancing agility and efficiency.

Robust

FinnFin diving fin system is designed to be used in highly demanding conditions: pressure, salt water, UV-radiation and the heavy forces caused by kicking with the fins. All the materials have been selected and all the constructions have been designed to account for these demanding conditions:

- The primary materials of the foot pocket are carbon fibre and Kevlar, and they are laminated using epoxy resins that are graded for marine applications.
- The buoyant angle material is very pressure-resistant: the material's compressive yield strength is graded to tolerate well over 200m depth's pressure. This pressure-resistance means, that the fin will have the same performance properties in the deep as it has on the surface, unlike typical fins that use compressible cell foam for buoyancy control.
- All attachment fixtures (screws, bolts, threads, plates) are made from stainless steel (A2), which makes them resistant to salt water corrosion.
- The liner material is also graded for salt-water use, UV-radiation and skin contact.
- The fin blades are made from carbon fibre or carbon/Kevlar hybrid.