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Bob Evans' Force Fins are kicking up market. Or not at all.

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FIN DOKTOR

Chris Kostman

by Chris Kostman

Whether hailed as brilliant visionaries or ridiculed as wacky tinkerers, Force Fins' iconoclastic creators Bob Evans and Susanne Chess have been actively proselytizing a fin revolution with their polyurethane fins shaped to resemble the tail end of a tuna or a dolphin.

Inspired by the natural locomotion of aquatic creatures, the fins have experienced broad acceptance from the swimming community, yet almost total disdain from the mainstream dive industry. Force Fins have weathered what their inventors believe to be unscrupulous efforts by competitors to undermine them in the US, yet are being used by the Russian Navy and Norway's Jaeger School (the equivalent of US special ops), and are now acquiring converts among Navy Seals, Marine Recon, and Delta Force Scout divers.

Evans started designing his own fins in 1971 in reaction to what he believed was a lack of progress in fin development. Although not formally trained in design, he had learned molding and other skills from his sculptor father. He turned to fin design full time in 1980, forever leaving behind his careers as an underwater photographer and producer of camera housings for deep water video.

He and Chess met in 1983, married two years later. She now directs the business side of the operation.

Discussion of Force Fins often focuses as much on their look as on their performance. Manufactured in stylishly tranluscent colors, the fins have won numerous design awards and were included in a Museum of Modern Art exhibit titled "Mutant Materials in Contemporary Design," and are part of the permanent collection in MOMA's Touch Tour for blind visitors.

Once thing's for sure—mention Force Fins to any diver and if they have heard of them, you're sure to get an intense reaction, one way or the other.

Here, in an exclusive interview conducted at their offices in Santa Barbara, California, is an inside look at Force Fins and their creators.

Your fins are such a radical departure from the fins we're all used to. Why are you redesigning such a basic piece of equipment?

Evans: Because they need it! There are actually several reasons. Every year I'd look at the new dive catalogues and see the manufacturers just kept repackaging the same old fins to make them look different. It was the same old thing: a board with a foot pocket on it. My first concept was that a fin should be curved on the backside, because you have to drag the fin back up through the water on the upstroke. Divers still think that they're getting power as they bring the fin up through the water. But there is no physical way that's going to take place with a flat fin. The hamstrings just aren't as powerful as the quadriceps. Plus, the ankle can't hold out against the water—it bends like a hinge or a trap door.

Another thing I recognized was that the ribs on the side of other fins didn't allow the water in front of you to get into the working area of the fin. The ribs were there to stiffen up the fin, but if you want to be able to maneuver, then those ribs are like a brick wall. A Force Fin is like a cup. The curved back side allows you to easily bring the fin back up through the water so you can kick back down. It carries the water one way, then comes back quickly to do that over again.

The market mindset seems to be that flexible fins don't offer any power.

E: That's true...if you have a flat, linear design that's flexible. But our fin is changing continually throughout the whole cycle. I saw a slow motion video of a harbor seal, and our fin is just like that. It has power in one direction and then collapses while throwing water behind in the other direction so that it can get back to where you kick against it without strain. You don't lose any directional flow of the water when it does this.

Upcurved wingtips?

E: They're a perfect foil. They provide lift. One of the America's Cup teams actually modeled their keel after our fins, based on the information derived from studying Force Fins in Boeing's wind tunnel. [According to Barnum Lambert of America[3], at maximum load of the power stroke, the Force Fin created minimum turbulence across the blade. The short fulcrum and low drag blade, he said, made the Force Fin the best design he tested.—ed] You see, unlike other fins, if you aren't kicking at all and are using your arms to drag you through the water, the fins will lift your feet up and hold them up. Other fins are like an anchor and just drag your feet down.

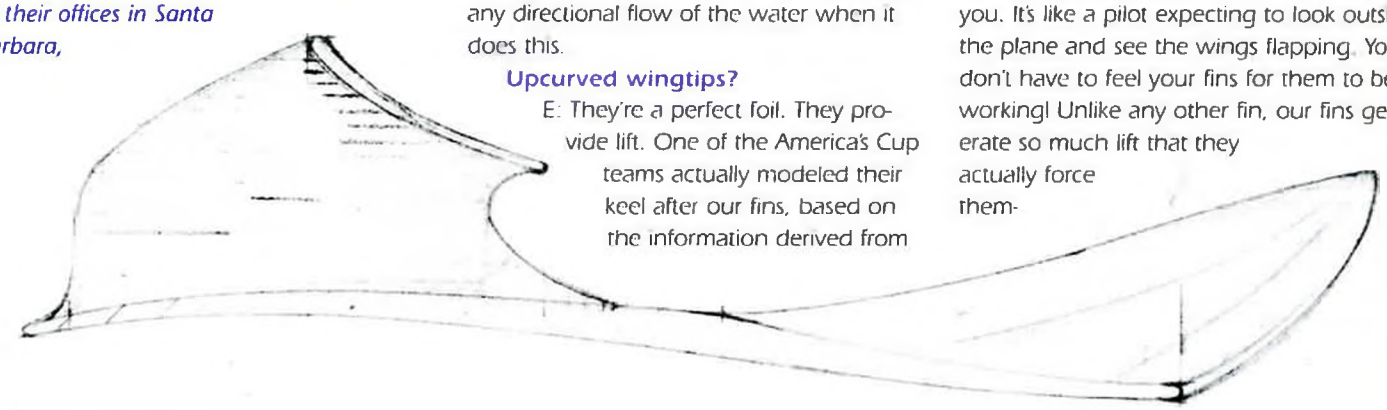
Force Fins are made of a different material than most other fins. Why?

E: Most fins in this industry are made of ethylvinylacetate (EVA), which is the cheapest plastic made. It costs about thirty cents per pound as raw material. My fins are made of polyurethane and they cost up to six dollars for the raw material. Everyone says plastic is great, but plastic is cheap, definitely not great, and only leads to higher margins for the manufacturer. For example, the plastic can't take heat well, so plastic fins lose their shape in your car or on the deck of your boat, which is why they come with a little shoe insert in them at the store. And once you start using them, they begin to collapse and don't last.

It's a bunch of crap that EVA plastic is the way to go. If you want to make a fin that's worth anything, use anything but EVA, with polyurethane being the best choice.

You told me that Force Fins don't need straps; they stay on by themselves and you only put them there because people wouldn't buy them otherwise. Tell me about that.

E: Are you working for the fin, or is the fin working for you? Just do a simple test: take the strap off and see if your fins stay on. If your fins fall off, then they're working on drag and they're doing nothing for you. If the fin stays on without a strap, then the fin is working on lift and it's working for you. It's like a pilot expecting to look outside the plane and see the wings flapping. You don't have to feel your fins for them to be working! Unlike any other fin, our fins generate so much lift that they actually force them-



Bob Evans

"ONCE THE DIVE INDUSTRY LETS IT REGISTER THAT MY DESIGN IS THE ONLY WAY TO GO, THEY'LL ALL GO THIS WAY. BUT THEY'RE GOING TO LET ME DO ALL THE WORK BEFORE THEY RIP ME OFF."

he could swim faster barefoot. He didn't say he *could* swim faster barefoot, just that it *felt* that way. In other words, he couldn't feel the fins, just like anyone who jumps in a pool and does a subjective analysis of our fins is going to discover.

C: You see, when you feel your fin, it gives you a lot of security. We're terra creatures. Our whole frame of reference for moving forward on land is resistance points on our feet. Force Fins are the only fins that you don't feel when you're using them, because they're the only ones moving the force vectors off your legs and onto the blade of the fin.

E: When *Undercurrents* heard about the Typhoon Lagoon "test," they thought, "OK, now we'll really get them. UCLA says the fins are no good and now the Navy says they're no good."

Your promo material cites another Navy study that found your fins among the most efficient. Why was that study more credible than the others? Because they liked your fin?

C: Because it was more scientific. Naval Sea Systems Command requested researchers at the University of New York at Buffalo School of Medicine to include Force Fin in the tests they were conducting on fins as part of a complete reanalysis of training technique and equipment recommendations for the Navy. In that study, held from 1990 to 1992, 200 subjects participated in tests of 35 different kinds of fins as part of a four-year research contract under the Department of Naval Research.

It was a test of efficiency under varying speeds held constant in a donut-shaped flume tank, so they're able to accurately simulate open water conditions. They were also measuring actual oxygen consumption.

But I heard that the divers didn't think Force Fins worked.

C: Well, every single person who participated in the study believed that the most efficient fin was the one they felt the most; in other words, the longer, stiffer fins. But paradoxically, the study revealed that, at all speeds, the most efficient fin was the smaller, more flexible fin, specifically, the Force Fin.

We requested the results of the study in order to combat the misinformation that was coming out within the dive industry. They told us us that both our original and pro model fins were in the top three to four overall, and other than the top five to six fins, the other thirty or so fins were really inefficient. But they didn't feel that they should release the results without the Navy's permission.

So, I contacted the Navy and they instructed me to do a Freedom of Information Act request, which I did. It came back and they denied us access to the records because there may be trade secrets involved and the information contained in this research may be detrimental to our competitors! So I sent off an appeal, saying, "Cross out the competitors' names. I only want the information about our fins."

Did you get the study?

C: A couple of months later, a three-inch-thick packet arrives with no cover letter! It's filled with all the original records and letters. Everything was in there, including the graphs showing ours to be among the most efficient fins. We started to cut and paste it and use it in our ads. Then two months later, an attorney from the Department of Naval Research called me and said, "We're thinking of denying your Freedom of Information Act request." I said, "What do you mean, denying it? You've already complied with our request." He said, "Well, what do you have?" And I said, "Well, what do *you* have?" We played this game back and forth and finally he said, "We're thinking of classifying this information." I asked, "What do you mean?" He answered, "Well, you know that everyone thinks a long, stiff fin is the most efficient? And you know that our research is bearing out that that's not true, and that actually the short, floppy fins are by far more efficient." I said, "Yes, that's why I want this research."

They classified it?

C: Well, next the Navy attorney said, "The reason we carry out this research is because we have combat divers and other countries have combat divers, and we don't want the enemy to find out that the short, floppy fins are the most efficient." So I said, "Hold on here. This is not privileged information. We've been saying that for years. You're not going to tell me that I can't have this research because of a security risk when we have a letter from the Department of Commerce that says that we are allowed to export our patented products, that there's no

FIN FLASHBACK continued

1975 Robert Semeia of Raphallo, Italy is granted a US patent for his Plana composite swim fins, using a unique method of joining two compositions at the planor portion of the fin. The patent is assigned to Mares, are first sold in 1978 as full-foot fins, and are a huge success.

1977 Ralph Shamlian patents a radical ridged footed fin that has an adjustable heel-strap and a pair of stainless rods that extend up the leg to the calf, where it is secured to the diver's leg by a Velcro fastener. The intent is to prevent the diver from involving his ankle. They are twice as expensive as the highest-priced fins on sale, and don't impact the market.

1988-89 Giovanii Garofalo, of Raphallo, Italy, patents fins that are sold by Mares as Plana Avantis. He modifies the original Plana fins, incorporating a canal-like member of softer, more flexible material within the blade. The blade of plastic-like material and rubber foot-pockets set the standard for modern fins and all but replace the dominant broad blade, vented rubber fins.

1989 Bob Evans patents Force Fins, throwing all predetermined fin concepts overboard. Shaped like a fish tail and made of liquid cast polyurethane, they are the first professional fin made entirely of plastic and are more flexible than rubber.

The Wenoka Reflex, constructed *ala* Plana with a plastic-type blade and rubber foot-pocket, has concave side-rails and three elongated, tapered sleeves built into the blade, designed to receive reinforcing battens. Each batten increases the initial 15-lb. blade tension by 5 lbs.

This timeline is based on a series of articles in Historical Diver. *For a sample issue, send $13.00 postpaid to the Historical Diving Society USA, 2022 Cliff Drive, #119, Santa Barbara, CA 93109.*

Bob Evans

national security risk or restriction involved. So you can't tell me you're going to now classify information about our fins, besides which I already have the research!" Well, he said, "We think that was kind of a mistake, you receiving that information."

Sounds like some serious political intrigue!

C: It gets better! I got a call from his commanding officer and the first words out of his mouth were, "You have my file." He was the naval attorney assigned to decide whether the study should be classified. But when he received his packet from the appeals office, where I'd written, the clerk had put his file in my envelope and then put the letter that was supposed to go to me in his file. It was just a clerical error that got me the file! At this point, the commanding officer said, "That's classified information and I want you to box it up and send it back to me with a letter certifying that you've destroyed all additional copies." Well, as Bob's darting out the door to make copies of the file, I'm thinking to myself, "Does this man have legal authority to demand this?" I mean, they sent it to me after I requested it, and it wasn't technically classified yet. So as I'm thinking this and hesitating, he said, "I guess you're not going to return the file, are you?" And so many people, at that point, might have gotten scared, but I said, "No, I'm not going to send it back." So in the end, he agreed to let us keep the file and said, "It's in the Navy's best interest to keep you in business."

Keep sending those checks.

C: The postscript to this story is that Force Fins are now being used by Special Operations, Delta Force Scout Divers, Air Force, Navy Seals, and Marine Recon as a diver preference item [the US Navy does not endorse any specific product—ed], and we're just one step away from being standard issue for everyone. In fact, we specifically came out with the black Tan Delta model because members of the Seal Team Five Bravo Company showed up at our door and they had been using the Pro Model in black, but wanted the Tan Delta in black. Like they said, "It's in the Navy's best interest to keep us in business!"

According to DEMA, about 425,000 pairs of fins were sold worldwide in 1994. The fin market is huge, but Force Fins are only a small part of the business. If your fins are so good, why isn't everyone diving them?

E: The misinformation in the US dive press is one reason. Another has to do with marketing. When we'd call dive stores about selling our fins, traditionally they have said stuff like, "I'm not interested in Force Fins. I'm a Scubapro store, or a Dacor store, or a U.S. Divers store. I only carry products from this company or that company." We feel that these buying programs have really worked to the detriment of the dive industry because the shops can't have diversity in the things they sell. Companies that sell one type of product, like us, can't get sold in those stores.

So we pushed our sales through other markets. Take our sales from 1984 to 1987 through The Sharper Image, for example. They sold nearly one million dollars worth of our fins with a money-back guarantee. They had less than a 1% return rate, most of which was based on sizing problems. And I have eight different sizes of fins, more than anyone else.

We also started selling through Performance Diver, and they have had only five pair come back in the more than four years since they started selling them. What the Performance Diver and Sharper Image experience meant to me was that if I could get my fins into somebody's hands, they'd like them and the continued p 72

THE HYDRODYNAMICS OF FINS

by Alfred Edward Nash III

Dive fins assist divers by increasing the forces that are created between their feet and water. Two forces created when divers move their feet are *lift* and *drag*.

Drag forces push on fins in the direction opposite the fin's motion through the water and allows divers to push themselves through the water like a paddlewheeler pushes itself across the water.

Lift forces push on fins perpendicularly to the direction of the fin's motion through the water and allow divers to push themselves forward like airplane's wing pushes it into the air from a runway.

The equations for lift and drag can both be written as:

Force on fin = 1/2 x Density of water x Speed of water around fin x Speed of water around fin x Drag or Lift Factor

The drag factor depends on (among other things) the surface area of the fin. The lift factor depends on (among other things) the curvature of the fin.

Long stiff fins are designed to be used with a wide, slow, traditional diving kick. They generate more of the force on the fin (which moves the diver forward) by increasing the drag forces, albeit with slower speed of water around the fin. (The Drag arrow in the drawing is larger than the lift arrow.)

Short, flexible fins are designed to be used with a narrow, quick, swimmer kick. They generate more of the force on the fin (which moves the diver forward) from lift forces and the speed of water around the fin. (The Lift arrow in the drawing is larger than the drag arrow.)

Slowing a diver's progress, however, can be several types of **resistance.** As a diver moves forward, water must move around him. This creates drag forces opposite the diver's direction of motion, slowing him down. However, the smaller the area perpendicular to the direction of motion, the less resistance there is on the diver.

The faster the diver moves through the water, the greater the resistance. The resistance increases the most when the flow of water past the diver changes from **laminar** to **turbulent.** When the flow of water around an object is such that the molecules trace out smooth paths, meaning it passes over the object as if it were made up of laminated sheets, the flow is said to be laminar. But if the water flows past the object faster than a certain speed, determined by the shape and surface of the object, the water will start swirling as it passes over that object. This turbulent flow increases the resistance force exerted on the object as the water passes over it more than does laminar flow.

The more streamlined in shape a diver is, the less resistance they will experience.

Complicating matters in any scientific analysis are the fin user's training and beliefs. Results are very training specific: one performs as they practice, and trying a different style can lead to disappointing results, unless the body is retrained. Divers also have certain expectations about fin performance, and those beliefs affect how the fins perform.

Alfred Edward Nash III, Ph.D. is a Masters swimmer and an engineer working with liquid helium at the Jet Propulsion Laboratory in Pasadena. Opinions expressed are his only and are not the opinion of JPL as an organization. He can be contacted @ al@squid.jpl.nasa.gov.

◄ continued from p 70 fins would sell. Selling through Performance Diver was like the Berlin Wall coming down for our business, because for the first time I was out of the grip of the old dive store relationship.

C: We were becoming successful without the dive magazines, without the support of the instructional agencies, without the support of the dive stores. And never in the history of this industry had anybody made it without those three support systems in place with them. We started becoming successful mostly through divers recommending our fins to other divers.

E: We still sell more fins to swimmers than to divers, but in the past year our wholesale orders to dive shops are up 300%, our government sales are up 300%, and our overall sales are at a level fifteen times what they were in 1988. We're also moving into a new 3,600 square-foot location. And this year we've introduced the Extra Force Fin, with patented variable thrust winglets attached. We're also selling these winglets, called Force Wings, as an aftermarket attachment for any fin.

What is the fin market going to look like in the next five or ten years?

E: Well, once the dive industry lets it register that my design is the only way to go, then they'll *all* go this way. But they're going to let me do all the work before they rip me off. Ten years ago, Dick Bonin, then the President of Scubapro, said, "I understand what you've done here, but I think it's going to take ten years for this industry to even begin to understand what you've done."

Oceanic just launched their new V-Drive fin, which seems to be based around some of the ideas you've been talking about. Do they understand it?

E: Three years ago at DEMA, representatives of Oceanic told us that they had done further testing of Force Fins after Barnum Lambert shared with them the results of the Boeing wind tunnel tests. They confirmed that their research showed Force Fin to be the best fin design. On the other hand, their marketing research showed that the instructional agencies weren't ready to accept the design. They would let us pave the way and educate the industry, then they would come out with their own fin using our concepts. It appears that they are now following through. In business, imitation is not flattery, it's thievery. Violating our intellectual property rights is tantamount to throwing a gaunlet at our feet. The story of David and Goliath might be appropriate.

What keeps you going?

E: Bev Morgan [of Kirby-Morgan and DSI fame—ed] once told me something: "If you're going to do one thing, do it well." That's why we have stayed in this one particular field. We will always be at the leading edge of fin design. It's what we live for.

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