The Leg Had To Go

Ten-year-old ***Kuroshio*** with new Arneson surface drive.

A comparison of the standard stern drive and the new-generation articulating surface-drive systems.

STORY AND PHOTOS BY DAVID MCRAE

In May 1995 I launched the *Kuroshio*, a 35' aluminum Armstrong designed for dive fisheries on the West Coast. Originally she was powered by a single 230-hp Volvo TAMD-43, driving a Volvo 290 duo-prop stern-drive leg. To be lucrative in the dive fishery the *Kuroshio* had to operate for eight to nine months, travel close to 9,000 nautical miles and bring in an annual catch of about 500,000 lbs. each season. The long hours of preparation specifically for sea urchin fishing during those first years made the *Kuroshio* one of the most successful fishing vessels in the dive fishery.

But this intense fishing schedule had one certain result: I was continually pushing the vessel's propulsion system beyond its design. Every day on the water there is wind to contend with, as well as constant maneuvering amongst rocks and debris while standing by the diver's bubbles. During each dive, crew is required to shift gears about once a minute, which adds up to about 500 shifts a day. With so much shifting, the potential of a major failure arises every time we engage the gears, and leads to the main cause of equipment failure. The only solution is constant maintenance, which necessitates a vigorous maintenance schedule to keep the stern drive running gear in operation.

The other factor adding to system failure is weight. The *Kuroshio* weighs in at 15,000 lbs. dry, and at the end of the fishing day the total weight may reach 25,000 lbs. Every three months I must devote several days to hauling out the vessel and removing the stern drive for maintenance. If I plan things well the whole operation only takes two or three days and involves a few bleeding knuckles and stinky gear oil. With a consistent schedule like this, usually no major pieces break and I only need to replace worn parts worth about $2,500 before getting the *Kuroshio* back in the water and working again.

About every 14 months or so the stern drive suffers catastrophic damage caused by an impact with a log or rock, or broken gears, broken rams, a worn cone clutch or sometimes the stern drive just rattles apart. But even with the maintenance schedule to haul out every three months and the need to install a new stern drive about every 14 months, I was able to keep the *Kuroshio* working full time, and rarely missed a day other than for mechanical failure. After the second replacement, the crew was faster at changing a Volvo stern drive than the guys in the shop. Resentment at having to miss work and spend even a few hours on the grid, sometimes in pouring rain, to repair the stern drive became a pain to all of us, and especially to me with the total cost of maintenance and replacements adding up to about $20,000 and 25 days per year.

Last year, after 10 seasons devoted to this agenda, I felt it was time to find a better system so I started researching alternative drive systems. I wanted to find a system that is fuel efficient, durable, has low maintenance and is capable of pushing the *Kuroshio* at 25 knots. I was certain I could find something to fulfill my needs.

Bigger Stern Drive

My first thought on replacing the Volvo stern drive was rather straight forward: just get a bigger one. The Konrad stern drive is substantially larger and stronger than Mercury or Volvo stern drives and can handle a much higher horsepower engine. But after viewing one I decided it looked pretty much the same as the stern drive I had, only much larger. Any increase in speed

Typical stern drives

Exposed shaft of a V-drive

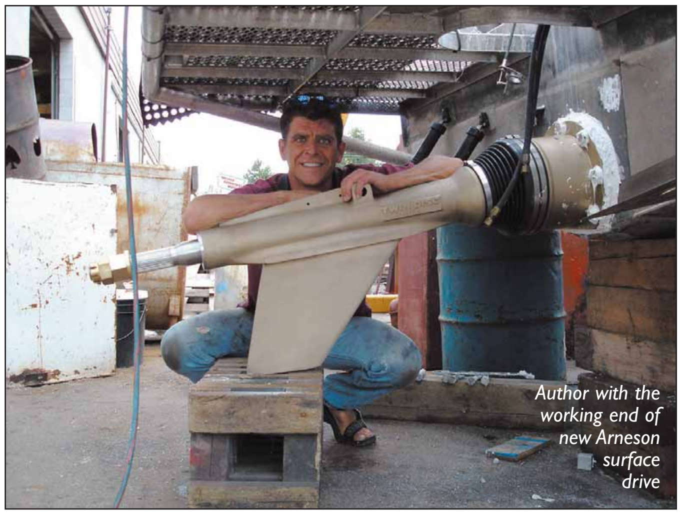
from a more powerful engine would be cancelled out by the increase in drag due to the size of the drive leg. I imagined having all the same troubles, but on a larger scale, so I deleted a bigger stern drive from the list of options.

V-Drive

Initial research on the V-drive system looked promising. There are many proven vessels equipped with this drive system; however, further research exposed a wide range of disadvantages. Looking at a diagram of the V-drive, I noted that the propeller angles downward, which appears to contradict an efficient propulsion system. Statistics showed there is also a considerable amount of drag from the rudder struts and propeller. The type of drag generated by moving a solid object through water is known as parasitic drag, which is the net effect from skin friction, interference drag and form drag. Exposed shafts also contribute to a large amount of power loss due to the Magnus effect, which refers to the turbulence created by the spinning shaft against water and the substantial transfer of power. Conversely, when shafts are enclosed there is likely a net power gain. At a glance the underwater assemblages, including the prop, struts and rudder, looked like trouble in the event of collision with rocks or debris, and would more than likely require a haul-out for repairs. Propeller efficiency is also difficult to maximize with V-drives. The diameter of the propeller is constrained by the length and angle of the shaft, which is likely to interfere with use of an optimum sized propeller. Overall, the V-drive just didn't seem to have the right stuff.

Jet Drive

The absence of a propeller made the jet drive option particularly attractive. Another advantage of jet drive is its shallow water capabilities, which are limited only by the draft of the hull. Operation in high-debris areas and in heavy kelp or seaweed would be a problem with clogging the jet intake, though it could probably be managed with careful maneuvering. But the real downside to a jet drive is the huge amount of horsepower required to run a vessel at 25 knots and the high fuel costs associated with it. Engine room space is limited on the *Kuroshio* and the area required to run a jet drive efficiently would take up more space than is available. I did, however, discover some new and innovative ideas while exploring the jet drive options. There have been major improvements in jet-horsepower technology that may be



Author with the working end of new Arneson surface drive more appealing in future but for now, the fuel bill that would result from running a jet drive made this option unattractive.

Arneson Drive

By chance I was discussing vessel repowering with Tim Summerville, captain of the *Intensity*, a 35' bow picker powered by two Arneson Drives. Tim commented, "Why don't you just get an Arneson?" Initially I had subconsciously written off the Arneson Drive since it is designed primarily for racing boats where a reverse gear is not necessary. I had convinced myself that you cannot back up with an Arneson, which is not true. Back-up capabilities are determined by propeller style, not the configuration of the drive. Surface piercing propellers designed for racing are typically cleaver style; the propeller has very sharp leading edges and the blades are concave and heavily cupped on the trailing edge. Since race drivers are not interested in backing up, this propeller design focuses on only one aspect of performance: forward speed. Another myth about the Arneson Drive is that they are too expensive; yet at first glance it seemed rather unlikely for any other drive system to cost more than the stern drive that took 125 days of my time and $100,000 over the last five years.

Fixed Surface Drive vs. Arneson Drive

A traditional fixed surface drive is a shaft exiting the transom

Arneson drive, prop, hydraulic steering mechanism

of the vessel and a rudder used for steering. When underway, the water line ideally passes directly across the hub of the propeller. The only surfaces that contact the water are the rudder and half of the propeller. This configuration virtually eliminates drag, and the Magnus effect is not present since the shaft is not exposed to the water. The major disadvantage of a fixed surface drive is that the propeller submergence

cannot be controlled and will vary with the weight of the load onboard. Maximizing efficiency of this system requires constantly redistributing the payload to enable the prop to be only half submerged when running.

The Arneson surface drive is an articulating drive. In other words, the shaft extending from the transom can be raised and lowered to accommodate varying payloads, which is accomplished by using two hydraulic rams: one for trimming the drive up and down and the other for steering side to side. The propeller shaft is mounted on a double u-joint enclosed inside a large ball joint. The drive unit itself is bronze and the rest of the components are made of stainless steel. All bearings, u-joints and seals are standard North American sizes and are commonly available.

The solid construction of the Arneson Drive and the fact that the shaft is located above the water line make it very difficult to damage the drive unit in the event of impact. It is possible to damage the skeg and prop, the only portions of the drive that are in the water. The most common surface-drive propellers are made from Nibral, a combination of nickel, bronze and aluminum. The effect of cavitation does not come into play with the Arneson Drive, since with each rotation the propeller blades are ventilated as they enter the water. Shallow-water capabilities are excellent. The drive can be trimmed above the hull in most installations. A number of models and sizes of the Arneson Drive, ranging from the AS6 to ASD18 are suited for vessels ranging from 20' to 140' in length. The drive can be powered by a gas, diesel or turbine engine. The virtual absence of drag associated with the Arneson Drive makes it the most efficient system available for fuel economy.

Arneson Drive Durability

To answer my question about durability, I consulted William

Kuroshio – first trial run with new Arneson drive

Strong at Victoria's Fisherman's Wharf. Having been involved in a large number of fisheries, William is currently fishing halibut in the summer and participates in the dive fisheries in the winter. Five years ago, he installed an Arneson ASD8 on his new 28' Northwest Aluminum Craft, powered by a Volvo 63 turning a Twin Disc Transmission with a 2:1 gear ratio. When I asked him about the durability of the Arneson Drive, he told me that everyone who does our type of fishing in the shallows and around rocks should get one. "The Arneson Drive cannot be beat when it comes to durability," he insists.

"I have a whole bunch of stories about how stable and tough they are," William says. "If I still had a leg on my boat, I would have knocked it off four times by now." He recalls one incident involving his Arneson Drive that demonstrates the durability he talks about. He was launching his vessel, the *Emma* at the boat ramp in Port McNeil. While in reverse the *Emma* backed into a gravel bar doing 1,500 RPMs. The collision stalled out the engine, but when he inspected the Arneson Drive, it was intact, including the propeller. "That one incident would have cost me my entire stern drive. And I've had a number of other incidents too. I have driven over logs – I mean real logs! It just won't break," proclaims William.

William Strong on halibut vessel ***Emma***

The stern drives available today are remarkable in their engineering, since they are relatively inexpensive and efficient; but they are designed primarily for light duty or pleasure use and are hardly compatible with the demands of today's commercial fishing vessels. For example, the Volvo Penta requires the stern drive oil to be changed every 100 hours to meet warranty specifications, which means a haul-out every few weeks. The time and cost of maintenance to keep stern drives operational in a commercial fishing environment are very time-consuming and expensive, and with today's need to have a vessel constantly working, it could spell economic disaster. But there are alternatives. The jet drive and V-drive systems have applications that are designed for specific uses, and they might work for you. The Arneson Drive has moved beyond the racing world and offers today's commercial dive fishermen a highly durable, low-maintenance drive system that goes faster and uses less fuel than any other drive – which is why I now have one in the *Kuroshio*.