Out of Africa

A South African engineer has joined forces with a British billionaire to create a radical new drive system that is set to change the way the industry views engine and gearbox configurations. **DENNIS O'NEILL** reports.

Mike Beachy Head has spent five years developing the Axis Drive.

The introduction of a new drive system into the marine industry is a rare and exciting event, and METS this year will see the European launch of the stunning and innovative Axis Drive from Caudwell Marine.

Team with a Nissan engine and available in three versions between 250hp and 350hp, the Caudwell Axis Drive is a power train without a universal joint.

The driving force behind this new product is a successful jet aviation engineer and businessman from South Africa, Mike Beachy Head, who has spent five years and US$40m bringing his imaginative idea to the market.

"It's a very difficult market to break into," explains Beachy Head. "Our competitors are amazed — they never saw it coming. Well it came from Africa," he says with a good deal of pride: pride for himself, his team and his country.

His desire to create a new and innovative propulsion system was prompted by his

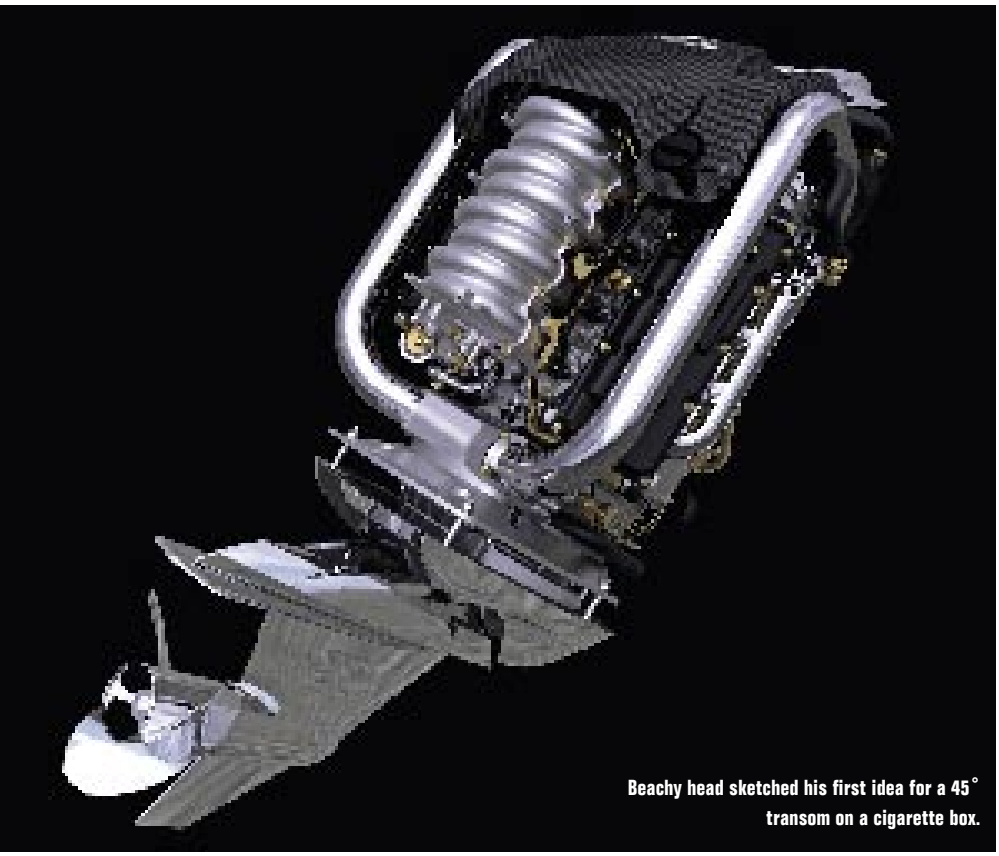
When steering, the entire gearbox and drive leg of the Axis Drive rotate around the same axis as the engine crankshaft, eliminating the need for a universal joint.

dissatisfaction with existing drives. "I had a nice two-stroke outboard but it was noisy and heavy on fuel," he says. "So I bought a brand new 7.4lt V8 sterndrive and within a year the universal joint was clattering around, the starting motor kept failing and it didn't handle very well.

"The biggest irritation, though, was the universal joint. I sent it back to the dealer a number of times and he just said to me that's what they do. So I asked him how can you

Caudwell Axis Drive specifications

Engine	250vi	300vi	350vi
Cylinders	V6	V6	V8
Horse power	250hp	300hp	350hp
RPM range	5,500-6,000	6,000-7,000	6,200-6,900
Compression ratio	10.3	10.3	10.5
Gear ratios	2.68-1.88	2.68-1.88	2.68-1.88
Weight	360kg	360kg	375kg



Beachy head sketched his first idea for a 45° transom on a cigarette box.

sell this product without wearing a stocking over your head?

"Then, one drunken evening, I drew a sketch on a cigarette box and came up with the idea of a 45° transom. The design intention was to have outboard performance inside the boat — and to get rid of the universal joint.

"I designed the very first drive myself. I taught myself CAD then used the tool-shop and equipment from the aviation side of my business to machine the first drive out of solid aluminium.

"Then we stuck an old Evinrude onto it and off we went.

"We were just having a bit of fun, we weren't thinking of it in commercial terms. Then we changed a few things here and there and when we got to the final iteration — version four — we knew this was better than anything else out there. It would even improve installation times."

The gearbox

The most notable and fundamental feature of the Axis Drive — which is tooled mainly from surgical grade stainless steel — is that steering is achieved by the rotation of the whole gearbox and drive leg around the same axis as the engine crankshaft. This successfully eliminates the need for a universal joint and separates the connection between the yaw axis, for steering, and the pitch axis for tilting.

The gearbox itself is composed of two cross shafts, connected by reduction gearing to reduce the drive ratios from 2.683 to 1.876.

The first cross shaft houses the clutch assembly and is mounted horizontally across the end of the input shaft. The input

Can the Axis drive succeed?

Caudwell clearly started with a clean sheet of paper and a very open mind when designing the Axis Drive. A new approach is certainly long overdue — the outboard motor dates back to 1906 and the sterndrive to 1948. The pod drive, first introduced by Volvo Penta in 2004 isn't really comparable, having been designed primarily for medium-sized motor cruisers with twin diesel engines.

Re-examination of first principles, lateral thinking and an uncompromising approach to engineering are at the heart of Caudwell's design. There is no reason why it shouldn't deliver the benefits claimed.

It has the weight distribution benefits of a sterndrive but uses a single 45° change of shaft direction instead of two 90° ones, and does away with the universal joint used by conventional sterndrives for steering and trimming.

The 45° steering axis is undoubtedly the drive's most unusual feature. The resultant twisting, pivoting, turning movement is difficult to visualise from the engineering images, but it has the advantage of automatically trimming the drive in (down) as steering lock is applied.

The use of twin cross-shafts at the head means that tilting and trimming is accommodated by the normal meshing of the transmission's gears.

Stainless steel construction should do away completely with the conventional aluminium sterndrives' *bête noire* — susceptibility to rapid corrosion in salt water. However, Caudwell's uncompromising engineering approach will surely be reflected in the price — so the company are right to position the Axis drive as a premium product, not intended to compete with mass market products.

One concern is that the Axis drive uses a single propeller at a time when twin counter-rotating props are more or less *de rigueur* for performance applications.

The case for twin props is that there's no torque steer in single-engine applications and that large blade area is possible without excessive diameter.

Caudwell says that thanks to the unusual geometry, the Axis Drive is torque neutral and the single propeller can transmit all the power into the water without problems, leaving fashion as the one remaining issue.

"Revolutionary projects in the marine industry are rare. This is a revolutionary product with global scale."

shaft then drives the clutch assembly that uses a spiral spline to engage and release the drive.

The second cross shaft receives the drive from the first and then drives the output shaft via a bevelled gear. Trim movements are pivoted on this second cross shaft.

"The gear train was conceptualised by us but the actual detail is by Xtrac," explains Beachy Head. "And we have also teamed up with Cosworth Racing in the UK on the superchargers.

"We put immense amounts of thought into all the details — such as the raw water systems, electronic systems and closed cooling systems — to see how we could best configure the drive control units.

"We wanted a soft engage clutch. With the Axis Drive you don't feel it engage because it is so beautifully smooth.

"And we spared no expense in the industrial design of our binnacle system. We designed all of its functionality and electronics.

"On this system the engine gets its power though to the propeller in both yaw and pitch without going through a universal joint. There isn't another drive system in the world that does that — it is silky smooth."

The fledgling project was given a huge boost when Beachy Head met British businessman John Caudwell who had won a charity auction to fly in one of Beachy Head's collection of 17 ex-military interceptor jet fighters at his aviation company in South Africa. Caudwell had sold his mobile phone company in 2006 for £1.46bn and was instantly impressed when Beachy Head showed him the prototype of the Axis Drive.

"I have an engineering background which gave me a particular interest in the development of this new drive," recalls Caudwell. "New and potentially revolutionary projects in the marine industry are rare and this was a revolutionary product with a global scale. The decision to make a substantial investment in the business was taken after some careful evaluation, but I am confident that it has a great future."

As the design matured, Beachy Head began to believe that they might have a winner on their hands.

"When a design concept is fundamentally right, other good things come out in harmony. One of the fortunate and unexpected benefits of the 45° transom is that the drive gets trimmed in as it turns, so the tracking and handling is remarkable.

"The propeller stays on the centreline of thrust — whereas a sterndrive articulates and therefore skids through the water.

"We also put a lot of thought into developing stainless steel technology for its construction. It is built with polished surgical grade duplex stainless steel. There is no paint on the unit. Duplex stainless steel is difficult to machine but it has twice the strength of other steels and it means that the expansion differential between the gear sets and casings is minimal, whereas aluminium casings have differential rates that increase gear wear. We get absolutely no gear wear at all."

"We see ourselves as a smaller kind of IPS where we articulate like a pod but with trim and tilt as well. And for installation, we're like an outboard."

The beautifully designed electronic throttle head.

Engine choice

"We then had to find an engine manufacturer to partner us. We looked at a number of engine alternatives, such as VW, Audi and Hyundai, but Nissan was way out in front. They weren't the cheapest but the durability and reliability is unsurpassed. I think they are the best engine development company in the world. We are incredibly fortunate to have them as a partner. They have given us great service and full information exchange. We have also been working with Pursuit as a boat partner."

Beachy Head believes that a new concept in propulsion is long overdue.

"I don't think marine companies are particularly visionary. In fact, the marine industry is very poor at innovating. The outboard has been around since 1907 and sterndrives since 1950. The outboard has certainly got bigger and quieter over the years but it was never meant to be a 300hp one-tonne behemoth hanging off the end of a boat. You were meant to throw it over your shoulder.

"I think Volvo did a fantastic job with IPS. It is a great innovation that has been very successful and it proves that innovation works. We see ourselves as a smaller kind of IPS where we articulate like a pod except we have full trim and tilt control as well. And as an installation package we're like an outboard. The unit comes complete in a box, you bolt it on with six bolts — and off you go."

International competition

Caudwell Marine's holding company is based in Stoke-on-Trent in the UK, with its design, development and assembly line located in Cape Town, South Africa. As part of its global marketing reach, the company has US-based development partners, with a marketing and distribution market joint venture being developed.

"We don't see ourselves as a threat to Mercury or Yamaha, or any of those guys. We believe that there is enough room for everybody and we want to be a small, specialist, high-quality niche player. We will support those boat companies who want to play in the area where it's not just about price, but quality.

"We intend to stay a relatively small operation producing around 300-500 units a year.

"There are lots of archaic things about the marine market — the way warranties are handled, for example. Dealers are left to sort it out while the boatbuilders abdicate their responsibility. But with us, if you have any problem that you can't fix through our online diagnostics, we will change the unit within 48 hours. We've committed a huge amount to our electronic training and the development of our downloadable diagnostics. The dealer sticks the USB stick into the binnacle and it will give you a complete report and gives you a list of solutions.

"In all it has cost around US$40m to get here," he says.

"To do this sort of thing you have to be a jack-of-all-trades. Managing engineers is like herding cats — they are brilliant people but a lot of them don't understand the timing or commercial realities of development. We developed this to a very strict time-line."

Beachy Head is also promising that an integrated diesel version will be launched soon with power options up to 550hp.

"We believe there is a gap in the market where the upper end of outboards and stern drives stops and where very high performance starts," says Beachy Head. "That's the kind of space where we want to be."

British businessman John Caudwell has invested in the Axis Drive.

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