RAindrops

Robert Allan Ltd. Information & News Issue 9

The Tugboat Issue

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Creating brand recognition for various types and classes

History of the Kort Nozzle in Canada

From cutting edge innovation to standard equipment

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Unlocking the complex performance characteristics with advanced modelling techniques developed from scratch

ROBERT ALLAN LTD.
NAVAL ARCHITECTS AND MARINE ENGINEERS

From the Engine Room

by: Dave H. Christopher, IEng IMarEng, MIMarEST, MNI
Senior Marine Engineer / Chief Engineer

When I embarked on my sea going career as an Engineering Cadet at the tender age of "late teenager", my main purpose in life was to visit exotic ports, enjoy lazy days at sea in tropical climes and try not to get incarcerated in some foreign port for behaviour not becoming that of a Junior Officer. I think I succeeded in most of those goals.

The accelerated promotion to 2nd Engineer with a Class 4 ticket on an anchor handling tug supply vessel in the Straits of Hormuz just a few short months after completing my cadetship, brought me down to earth very quickly. I suddenly found myself in charge of a watch, and learning that pumping mud, blowing cement and pulling anchors was to be the mainstay for me over the next few decades.

Apart from a couple of brief spells back "deep sea" during the lean times of the offshore oil industry in the mid 80's, I spent a very large proportion of the next 26 years serving on pretty much every conceivable type of offshore vessel there is. The challenges of anchor handling in shallow water <10m or deep water >2000m, DP'ing in heavy weather, pumping 4 different cargoes at once, and towing through horrific storms across the Indian Ocean provided me with the opportunity to really look at the boats I was working on. The way various components of the deck equipment integrate, the reliability of the engine room machinery when running for long periods of time, and of course the amenities available to those onboard. After 60 days of 12 hours on, 12 hours off winch driving, you begin to miss a few creature comforts!

Not all my sea-going career was spent on ships actually at sea. Occasionally, I was granted the opportunity to spend time in shipyards doing repair work, managing conversions and watching designs come to life. One project I was involved in had me carry the design drawings to the shipyard and then 10 months later sail the vessel away as its first Chief Engineer. That tug is still in operation today, and although its original area of operation was the Far East, I followed its career from there to the Middle East, Central America, a dry-dock in the U.S. and now it is working on the Great Lakes. A wonderful feeling of achievement for me, and hopefully a vessel of satisfaction to the current owner.

Now I find myself sitting behind a desk and to me this is the perfect culmination to my career. Being in a position to provide insight to the design of an OSV, where once I criticized the designer or builder adds that level of completeness to my career but also to a few Robert Allan Ltd. designs. It may only be in the positioning of bunks in a cabin, or the layout of deck equipment to achieve a solution that meets the industry safety standards, but either way, I hope that my participation provides the icing on the cake when it comes to reassuring our clients that every aspect of their vessel has been considered, and that as an Owner the input from an experienced crew member in their design team has added the finishing touch.

What's in a ***NAme***?

by Robert G. Allan, P.Eng.
Executive Chairman of the Board

Over the past two decades or more Robert Allan Ltd has been very successful at creating international brand recognition for its various types and classes of tug designs. In deference to the Company name, most of these classes have been given designators which, not surprisingly, begin with "***RA***"! However it is perhaps less obvious to our Clients (and sometimes to our staff!) what these various names represent in terms of the performance attributes of each of these tug types. The purpose of this article is therefore to perhaps shed a "***RAy***" of light on what is presented by each of the main tug classes used by Robert Allan Ltd.

We characterize our tug design portfolio initially according to the propulsion system used, creating three basic groupings:

- Conventional Screw Propellers
- Z-Drives
- VSP Drives

Each of these has variants according to the placement and number of the drive units: e.g.

- Conventional Screw Propellers
  - Single screw
  - Twin Screw
  - Triple Screw
  - Quad Screw
- Z-Drives
  - Azimuthing Stern Drives (ASD) - drives aft
  - Z-Tractors - drives forward
  - Rotor Tugs - triple Z-drives
- VSP Drives
  - Voith Tractor - drives forward
- ***RAVE*** - drives fore and aft

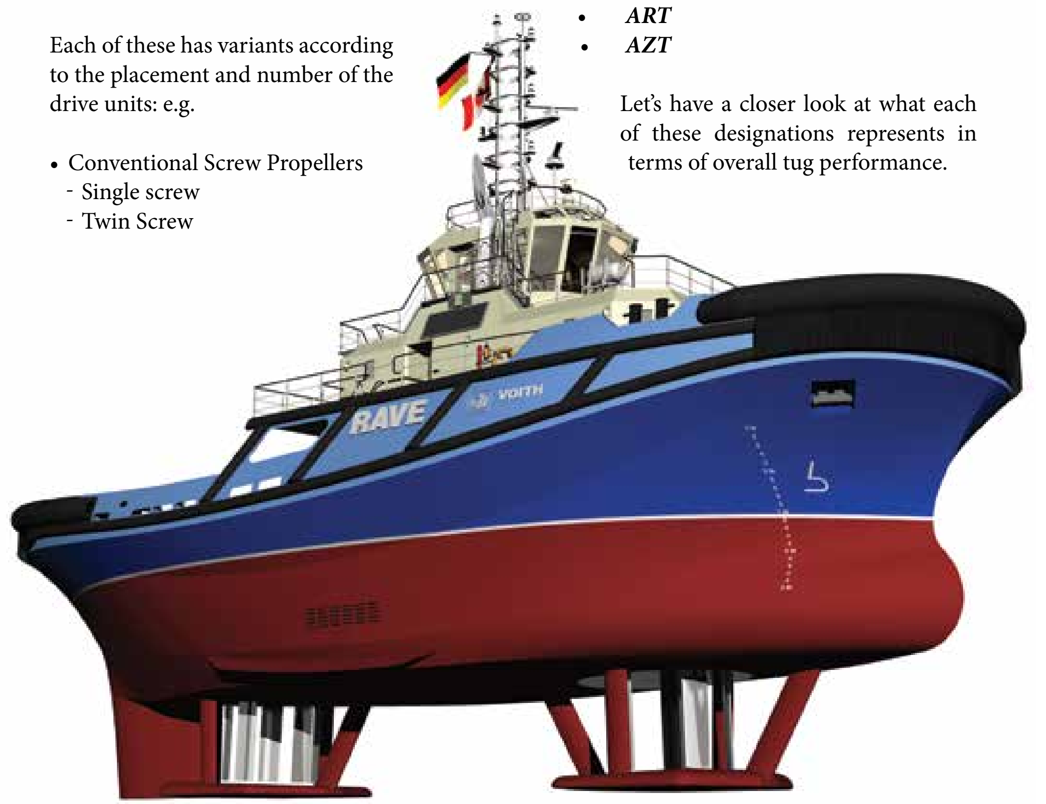
Then within these major categories there are hull designs which have been created to best respond to the demands of different tug services, it being our firm belief that there is no such thing in tug design as a "one size fits all" solution. Thus we create our ***RA***… type designations, such as;

- ***RAmparts***
- ***RAmpage***
- ***RAstar***

…and those for which there simply are not enough good "***RA***" words; e.g.

- ***AVT***
- ***ART***
- ***AZT***

Let's have a closer look at what each of these designations represents in terms of overall tug performance.



RAVE *Series High-performance Escort and Ship-handling Tug Concept*

RAmparts 3200

RAmparts Series

This is our "bread and butter" series of tug designs, developed for general ship-handling, port and near coastal duties. Originally conceived to be a modular, expandable design, the name, denoting "a means of protection or defense" (so appropriate to tug operations), was also an acronym for "***R***obert ***A***llan Ltd. ***M***odular ***P***arts". In general the modularity of this design series has not been followed through as extensively as first envisaged, as it is difficult to achieve this modularity in tugs of varying lengths without creating ugly hulls, anathema to one of our fundamental design missions in this company! Many elements of the ***RAmparts*** designs are used in common however to reduce the overall design costs and delivery time.

Many classes of ***RAmparts*** tugs within this series have been built, with varying beam/draft and beam/length ratios to suit the specific needs of various clients and to cater to a range of powers installed in the same length of boat.

RAstar Series Escort Tugs

The ***RAstar*** series tugs are designed expressly for high-performance tanker and ship escort duties. These feature our unique sponsoned hull form which significantly enhances escort performance in the heeled attitude of an escort tug, and in addition this shape offers very significant benefits in reducing roll motions and accelerations, making it the star of all hull shapes for offshore terminal tugs as well as for escort.


RAstar 3200

RAmpage Series Offshore Tugs

The ***RAmpage*** series are heavy duty, offshore support tugs, designed primarily for oil terminal or offshore exploration sites where high BP and a significant anchor-handling capability and some cargo capacity is required, but not to the extent that a very large AHTS is required. These are large sea-going tugs, mostly in the 45-65 metre range, with BP generally of 100 tonnes or more.

RApide River Tugs Series

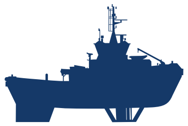
The ***RApide*** tugs are by definition very shallow draft pusher tugs and typically will have multiple propellers or drive units according to the application. The origins of this type of vessel reside in very unique design work done for Canada's northern rivers in the early 1970's, which served as the basis for a whole new generation of river tugs currently being developed for major river transportation projects, notably in South America. Due to the unique needs of almost every project each ***RApide*** class tug is custom designed to suit a specific set of operational requirements.


RAmpage 5000 Z-M


RApide 4617-Z-3

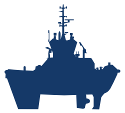
AVT 3700

AVT Series



The "Advanced Voith Tractor" series tugs are Voith-powered, high-performance escort tugs, embodying the same sponsoned hull form which characterizes the ***RAstar*** class ASD tugs, and thus offering truly enhanced escort and seakeeping performance.

AZT Series



The ***AZT*** series are essentially similar to the ***AVT*** tugs, but with Z-drive propulsion in a tractor (drives forward) configuration, rather than VSP drives, and embodying the sponsoned hull form characteristics.

ART Series

The ***ART*** series denotes our "Advanced Rotor®tug" designs, which typically also include the ***RAstar*** style of sponsoned hull geometry for enhanced escort performance. The Rotor®tug concept, with three Z-drives in a triangular format, excels in providing enhanced manoeuvrability and the ability to apply high lateral forces in constrained areas, as well as the unique "Rotoring" operation where the tug can effectively "push on the towline" in close proximity to the attended ship.

At the end of the day these names are useful handles by which we can convey the various functional capabilities of different tug design types to our Clients, and to help keep the distinctions clear in our own minds!

ART 80-32

Ensuring Tanker Safety in Coastal Waters

by Robert G. Allan, P.Eng.
Executive Chairman of the Board

As a frequent kayaker in the beautiful mid-coast of B.C. I am well aware of what is at risk from a polluting incident. However too much discussion in the press to date has centred on oil-spill recovery capabilities, and very little on the far more critical spill prevention measures necessary to protect this sacred coastline. It is critically important to understand the proven technologies available today to help safeguard our coast.

The spectre of another ***Exxon Valdez*** tragedy is often cited as a likely outcome of increased tanker traffic on the B.C. coast. However, the maritime world has changed dramatically since the enactment of various International Laws and the U.S. Oil Pollution Act of 1990. To ensure that such an incident could not be repeated, a single-hulled tanker (such as ***Exxon Valdez***) has been mandated out of existence since 2010 by the enactment of the International Maritime Organization (IMO) Marine Pollution Act (MARPOL) Annex 1, and as affirmed by Canada under the Canada Shipping Act; Vessel Pollution and Dangerous Chemicals Regulations. The use of double-hulled tankers means that in the unlikely event of a grounding, a great deal more energy must be expended to breach an inner cargo tank to cause a spill than was previously the case.

A tanker is a machine which can occasionally have mechanical problems with its propulsion or steering systems. If those problems occur well out to sea then there is almost no risk; the crew will usually be able to fix the problem in short order. If however that failure occurs in a near-coastal environment there must be systems in place to ensure that the tanker does not go aground. Enter the high-performance Escort Tug.

Since 1990 extensive research and development has led to the design of large and very powerful tugs which act as an emergency steering device in event of a tanker rudder failure, or as a very powerful "hand brake" in case of a propulsion failure. A significant majority of these escort tugs worldwide have actually been designed here in Vancouver by Robert Allan Ltd., and operate at major oil and gas terminals throughout Europe, U.S.A., South America, Middle East, Africa and Asia. The capabilities of these tugs have been verified by extensive scale model-testing and research, and by full-scale trials. Featuring unique hull forms which can generate very high hydrodynamic forces, and with powerful 360 degree steerable thrusters, these escort tugs bear little resemblance to the small log or barge towing tugs with which British Columbians are familiar. Designed to provide forces equivalent to or higher than the tanker's own steering and braking capabilities at high operating speeds, an escort tug operates "tethered" to the tanker and is immediately available to exert very high steering or braking

forces as required. The above photo illustrates the 42 metre, 10,400 HP Norwegian escort tug ***Ajax*** performing an escort manoeuvre in the North Sea.

The escort tugs envisaged for the Northern Gateway Pipeline project would be the largest and most capable of this class operating anywhere in the world. Fifty metres long, with more than 10,000 horsepower, they can generate corrective steering and braking forces up to 200 tonnes. These will dwarf any existing tugs on the B.C. coast. They are designed to provide the tanker escort capability and also to perform rescue towing should a non-escorted tanker be disabled anywhere within the 200 mile limit of Canadian waters off the B.C. coast. Two of these "super tugs" will escort every tanker enroute to and from Kitimat. Laden tankers will have one free-running tug checking the route ahead of the ship and one tug tethered astern. Empty tankers will have two free-running escorts, one forward and one aft. In addition to the huge safety margin provided by escort tugs, no less important is the extra number of trained eyes and ears available within the escort system to detect a potential incident. The lead tugs will identify any potential marine hazards, suggesting course or speed corrections to the tanker Pilot as necessary. The Master of the stern escort tug is uniquely positioned to detect any potential off-course error of the tanker, where he can exert corrective action within seconds. In addition, the presence of two B.C. Coast Pilots aboard the tanker itself, plus the ship's Captain, means no less than 5 professional mariners are paying attention to the tanker course at all times.

The extensive escort tug operations planned for the NGP will provide as close to a zero risk operation as is possible.

History of the Kort Nozzle in Canada

by Robert G. Allan, P.Eng.
Executive Chairman of the Board

The Kort nozzle was developed by German engineer Ludwig Kort (1888-1958) in the 1930's, and it found wide acceptance in the inland waterways of Europe from that period onward. In the 1950's the engineering of the Kort nozzle was centred in Bureau Kort in Germany. The first application of a Kort nozzle in North America is believed to be the tug ***Kam***, later ***Abitibi***, built in Quebec in 1939.

Seeing the merit of this device for towing systems, Mr. R.F. Allan negotiated a licensing arrangement in 1964 with Kort for Robert Allan Ltd. to be the only licensed designer of Kort Nozzles in Canada, an arrangement which paralleled an agreement between Western Propeller Ltd (a division of John Manly Ltd) and Kort as the sole licensed builder of nozzles for Canada. This arrangement worked well and more than 100 nozzles were built for both new construction and refits of tugs in B.C. and the U.S. Pacific Northwest. However as the use of nozzles became more widely accepted and others found design information readily available, the exclusive licensing arrangement with Kort was no longer competitive, and in 1972 the license arrangement was terminated by mutual agreement.

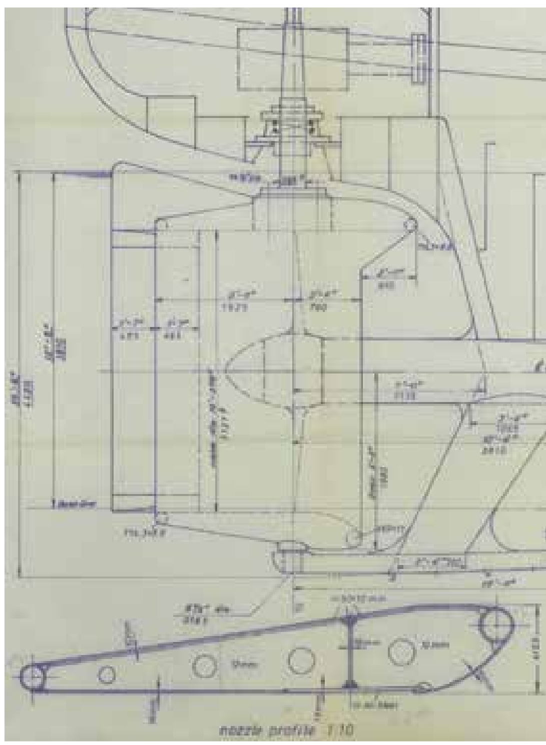


Figure 1: Early Kort Steering Nozzle ca. 1965

The early nozzles had rather elongated profiles as per Figure 1. Later designs evolved to a much higher aspect ratio as shown in Figure 2, and were typically fixed nozzles with independent single or multiple rudders.

However the major story for Kort nozzles in B.C. came with the construction of four sister tugs for MacMillan Bloedel's marine division, Kingcome Navigation. Robert Allan Ltd was awarded the contract for the design of these tugs in 1962, and advised the Client immediately of the advantages of the Kort nozzle for the intended primary application of log towing. Log towing is in fact an almost ideal application for nozzles, with highly loaded propellers working essentially continuously at low speed.

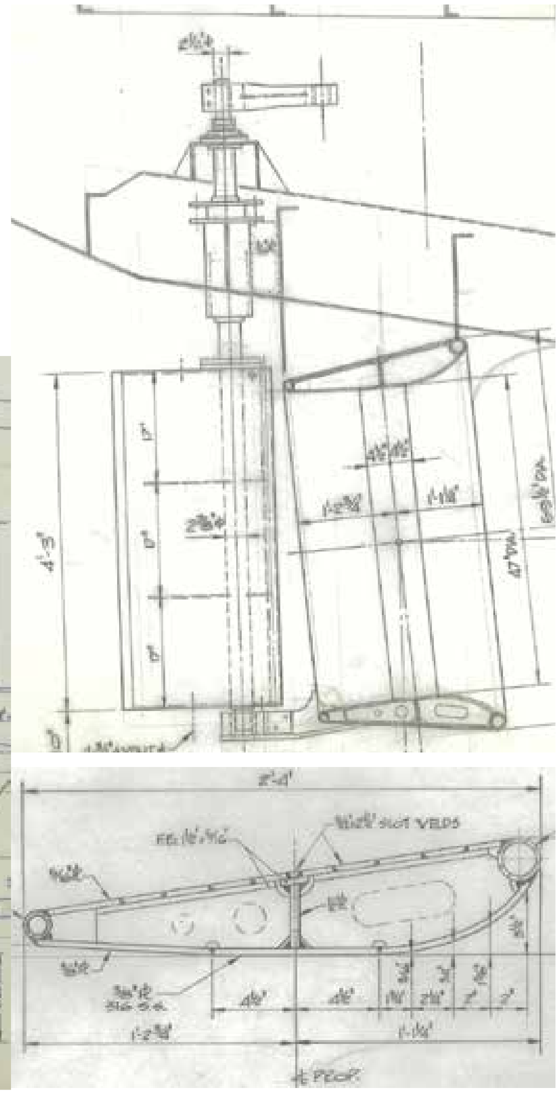


Figure 2: Kort Nozzle/Multi-Rudder Configuration of the mid '70's

*Figure 3: **Harmac Fir***

The tugs, delivered in 1964 and 1965, were the ***Harmac Fir*** (Figure 3), ***Harmac Pine***, ***Harmac Cedar***, and ***Harmac Spruce***. The tugs were identical in every respect except for the propeller/nozzle designs.

The nozzled tugs, ***Harmac Fir*** and ***Harmac Cedar*** so out-performed their open-screw sister ships that within a very short time the open-screw tugs were converted to nozzles as well. The conversions however were to fixed nozzles rather than steering nozzles. Of significant interest is how the speed of the nozzle tugs was also substantially higher, as well as the 25% increase in BP values.

The success of this unique "experiment" certainly was a catalyst to the widespread acceptance of Kort nozzles within the B.C. tugboat industry. Since the early 1970's Robert Allan Ltd has not designed another open screw tug for any application except in ice.

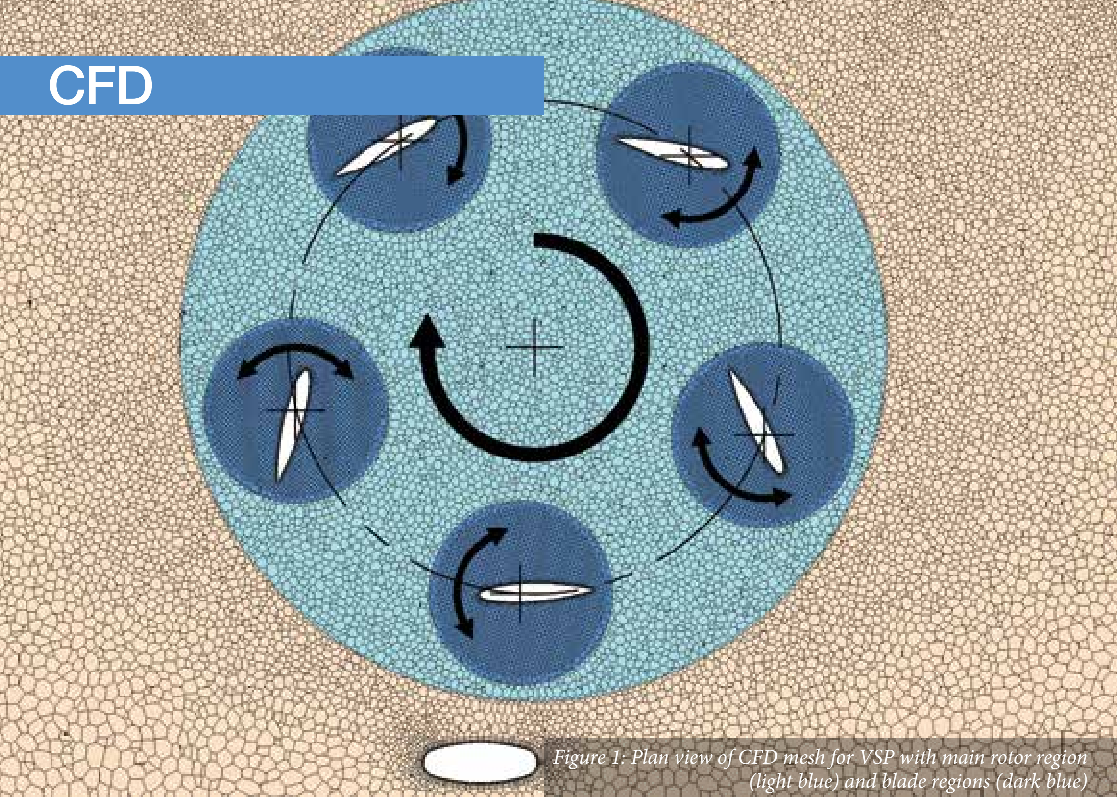


Figure 1: Plan view of CFD mesh for VSP with main rotor region (light blue) and blade regions (dark blue)

Figure 4: Bow view of ***AVT 3000*** with VSP blades and propeller guard visible

Analysis of a Voith Schneider Propeller with CFD

by Bart Stockdill M.A.Sc., P.Eng.
Mechanical Engineer

Over the past few months, Robert Allan Ltd. has developed advanced analysis techniques for modelling Voith Schneider Propellers (VSP) using Computational Fluid Dynamics (CFD) in an effort to optimize the design and performance of the Advanced Voith Tractor (***AVT***) class of tugs. This development work has been carried out in cooperation with *Voith Turbo Schneider Propulsion GmbH & Co. KG* who have extensive experience modelling the VSP with CFD. Even with Voith's guidance, much of the modelling technique was developed from scratch to take advantage of the features available in the latest version of the CFD software package StarCCM+.

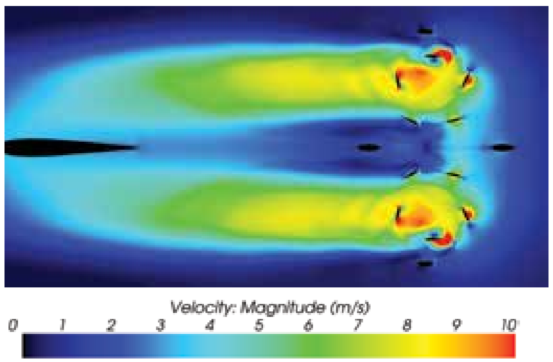


Figure 2: Plan view of velocity contours at mid-height of VSP blades

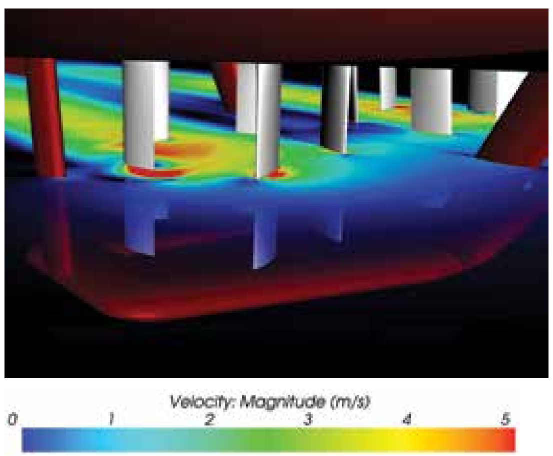


Figure 3: Perspective view of velocity contours at mid-height of VSP blades

VSP simulations are complex since the propeller blades continually change their angle of attack in a non-linear way as they orbit around the rotor. Figure 1 (above) shows the CFD mesh at the mid height of the propeller blades where each blade is encased with its own rotating region shown in dark blue; the rotation is continually incremented to control the magnitude and direction of thrust by adjusting the blade angle of attack. The outer region shown in light blue encases all of the blade regions and rotates at a constant rate; this provides the driving force needed to produce thrust.

Since the complex motion of the blades involves superposed rotation, meaning that the blades rotate simultaneously about their own axis and about the main rotor axis, very fine time steps are required in the CFD simulation, much finer that would normally be used for a conventional propeller with a constant rpm and blade angle of attack. In fact, a VSP simulation takes about 20 times longer to run that a standard z-drive simulation. This translates into a computer run time of about two weeks, compared to less than one day for a z-drive simulation.

Though computationally expensive, the VSP simulations offer powerful visual results which give engineers intimate knowledge of the hydrodynamic behaviour of the flow around the propellers blades and its interaction with the hull. Figure 2 and Figure 3 (opposite page) show the velocity contours on a plane at the mid-height of the VSP blades. Dark blue areas indicate low velocity and red areas indicate high velocity. Black areas indicate zero velocity and also show the skeg and propeller guard struts. One of the key characteristics of the VSP is that the blades only produce thrust during a portion of their orbit path around the rotor. In Figure 2, the port VSP (top) and the starboard VSP (bottom) are producing net thrust to the right (forward). This thrust is produced as the blades are moving aft on the outboard side of the rotors and is indicated by areas of high velocity (red) on the suction side of the blade and low velocity (blue) on the pressure side of the blade. As the blades move forward on the inboard side of the rotors, they produce no thrust; this is indicated by uniform intermediate velocity (light blue, green) on both sides of the blade.

Besides providing intimate knowledge of the flow behaviour near the hull, CFD simulations also show the wash plume behaviour as it propagates away from the tug. Figure 5 (front cover) shows the wash plume for an ***AVT 3200*** after 40 seconds of operating at 70 tonnes bollard pull. The plume extends several tug lengths astern and has an outer velocity of about 2 m/s; these flow characteristics can be useful for determining the environmental impact of tug operations such as seabed scour.

VSP simulation times are expected to improve dramatically when Robert Allan Ltd. commissions our new High Performance Computing (HPC) next month. The cluster has 320 processor cores running at 3.0 GHz with 2048 Gigabytes of memory and 48 Terabytes of storage. The new cluster will increase the CFD processing speed by a factor of ten, bringing VSP simulations into a timeframe more amenable to commercial design work. Other areas of CFD such as seakeeping, directional stability and manoeuvering simulations will also be become more accessible which will in turn further enhance the quality of Robert Allan Ltd. designs.

RAIndrops

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Front Cover: Perspective view of wash plume velocity contours in bollard pull for ***AVT 3200***

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