Rolls-Royce

Automation and Control

Human-machine interface for ease of control

Focus on safety, performance, simplicity and proximity

Rolls-Royce offers a full range of marine automation and control systems to suit most types of vessel, ranging from fully integrated bridge systems with the Unified Bridge ergonomically designed human/machine interface to propulsion/thruster/rudder control, dynamic positioning and alarm and monitoring systems. Much of the equipment can also be supplied as stand-alone products.

Contents:

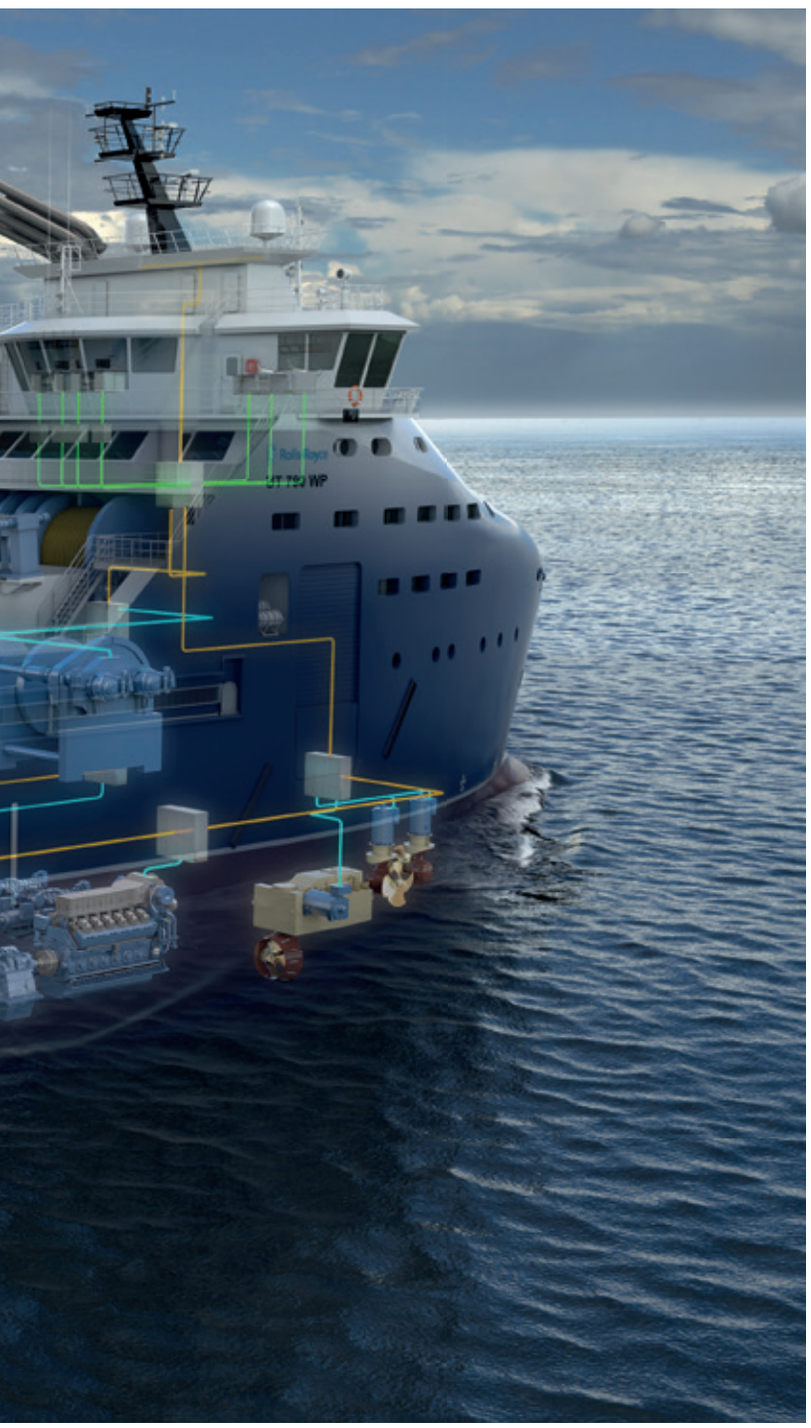
human-centred design

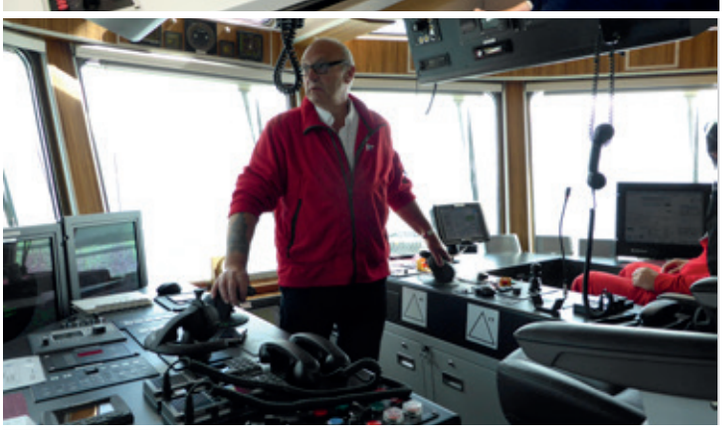
High level system integration

A ship is a complex assembly of systems and items of equipment, all of which have to be controlled and monitored. Rolls-Royce is a systems integrator providing a vast array of products and systems for ships of many types, including large CP propellers, thrusters for propulsion and manoeuvring, waterjets, stabilising and motion control, deck machinery, tank systems, diesel and gas engines, LNG fuel systems, and power electrical hybrid systems with batteries. In many cases we also provide the designs for the ships themselves.

All of these systems and sub-systems need controls, alarms in case of problems, and automation. We have built up enormous expertise in this area, ranging from control and monitoring of simple items of equipment to the extremely safety critical control of nuclear power reactors.

During recent decades Rolls-Royce automation systems have been expanded in scope and developed through several generations, from simple tank-sounding in the 1960s through UMAS, to today's comprehensive Acon Integrated Automation System (IAS). Like other systems it has been based on the Rolls-Royce Common Control Platform since the middle of the previous decade. In the same way propulsion and thruster controls have gone through several generations of development.





Automation, propulsion control and dynamic positioning are just some of the equipment that can be provided as sub-systems for a wide range of vessel types. All are based on the Rolls-Royce Common Control Platform and modular hardware and software for ease of interfacing and simple installation.

Positioning systems have been the subject of intensive development, starting with the Poscon joysticks in the 1970s. Rolls-Royce DP systems meeting the various IMO requirements followed.

The Rolls-Royce Common Control Platform allows systems to be easily interfaced with each other, minimising the amount of cabling and simplifying installation at the shipyard and subsequent maintenance in service. Ethernet and CANbus are the main internal communication links for this. Selected navigation systems can be integrated with the Rolls-Royce system, operated from the multifunctional touch screens. Other third party products are interfaced via various communication links including ethernet, various field bus, serial bus and analogue or digital input/output; accessed and operated using the Acon Bridge Control touch screen.

Unified Bridge collects the controls and status information for all these systems and presents them to the people responsible for operating the ship in a clear and logical way, helping to reduce fatigue, prevent mistakes and misunderstandings and so improving safety at sea.

Unified Bridge – within arm's reach

Like an iceberg where the visible glistening part is only a small fraction of the whole object, the Rolls-Royce Unified Bridge is the human-machine interface of a broader and deep integration of ship systems.

The role of Unified Bridge is to provide the operator with a functional and easily used human-machine interface with ergonomically placed control levers, touch screens by which systems can be called up and controlled, and logically presented information on system status.

The goal is to lower the operator's cognitive load and make the workflow more efficient. In safety-critical situations a lower cognitive load will require less attention on how to operate the system and enable more focus on the actual operation, hence increasing the operational safety. This reduces the risk of environmental consequences of possible accidents causing damage to crew, vessel or installations. Over many years we have devoted substantial resources to development of systems and human-machine interfaces on board to support the complexity of marine operations today.

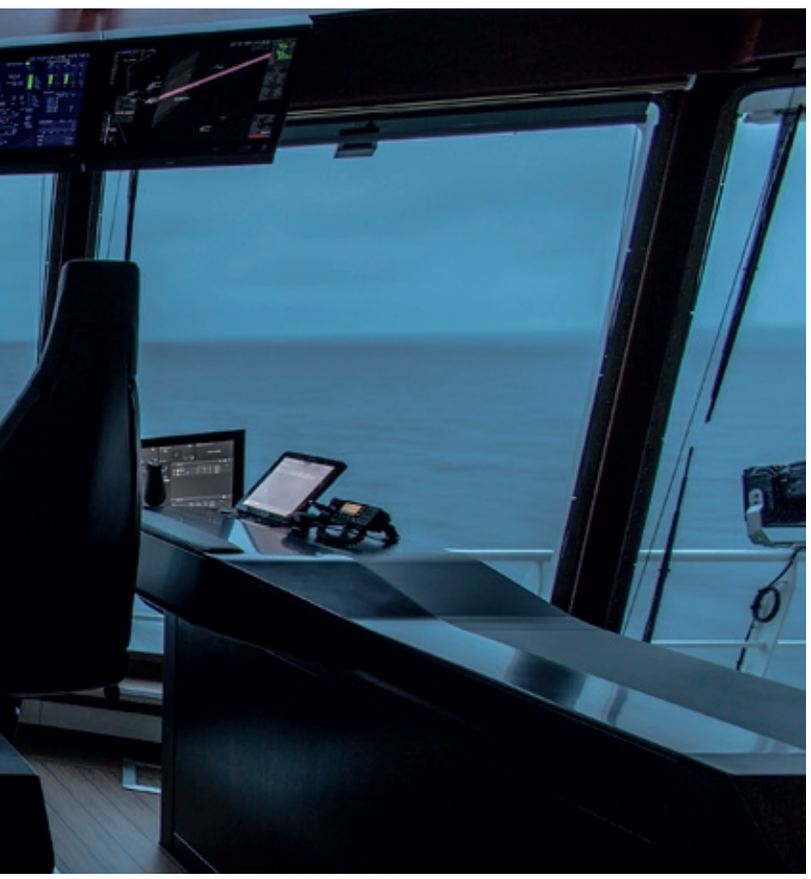
Our Unified Bridge offers the operator performance, simplicity and safety with proximity.

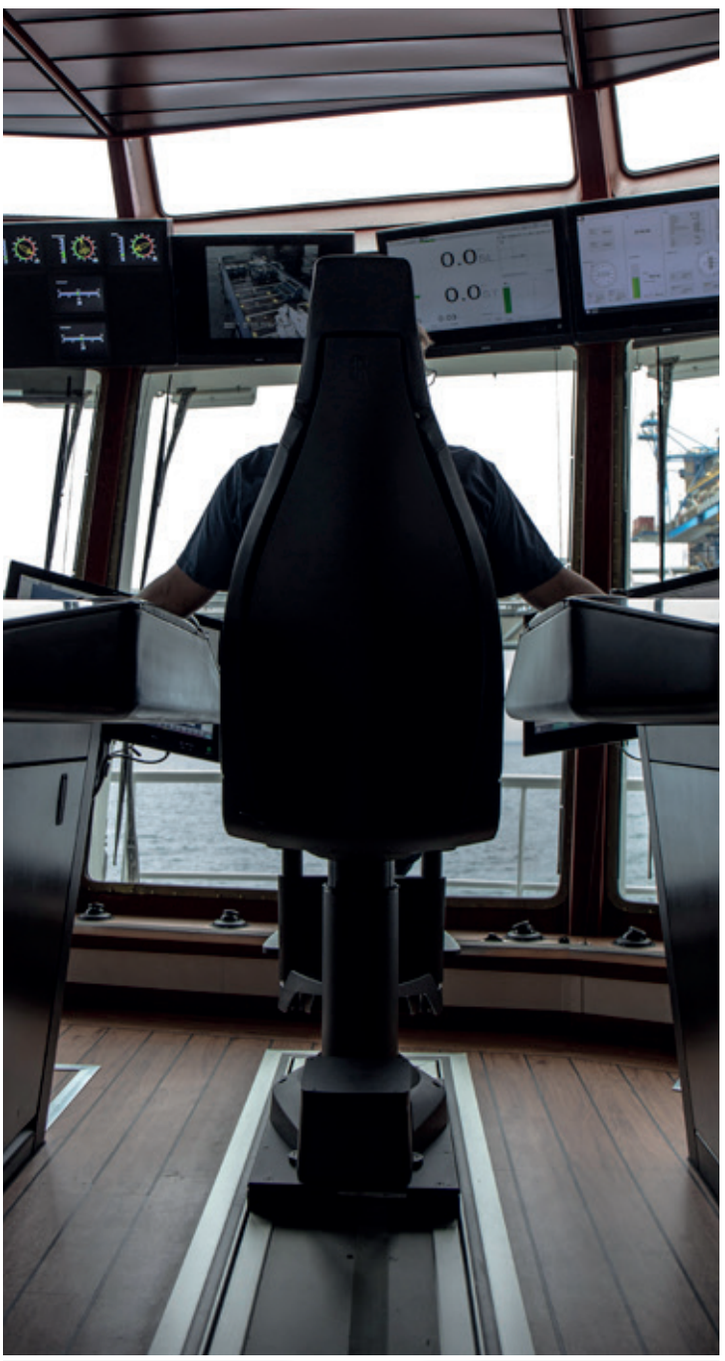
Proximity is having information that the operator may require quickly and unambiguously available, and controls conveniently at hand to carry out whatever action is needed. The graphical user interface is clear, and based on the philosophy 'what you see is what you need'.

The brigde itself is built up from a series of modular consoles with controls and screens, the layout of which is designed to suit various types of vessels. Its design is based on results from a continuing Rolls-Royce human factors research project which has involved observation studies and data collection from vessels in service, to establish what ships' crews actually need for safe and effective ship operation, and how best to present information without cognitive overload. The research work has also included testing experimental layouts to evaluate the cognitive loads on dynamic positioning (DP) operators.

Key product benefits:

- Holistic user experience
- Proximity to monitoring and controls
- Consoles, levers and chairs are ergonomically developed
- Software application interfaces are consistent and well-designed
- Unified alert handling from one location
- Unified dimming of lights from one location
- Variation of work position, seated or standing
- Improved view of the aft deck for PSV and AHTS to support safer operations
- Integration of auxiliary equipment (wipers, lanterns etc.) for control from one location





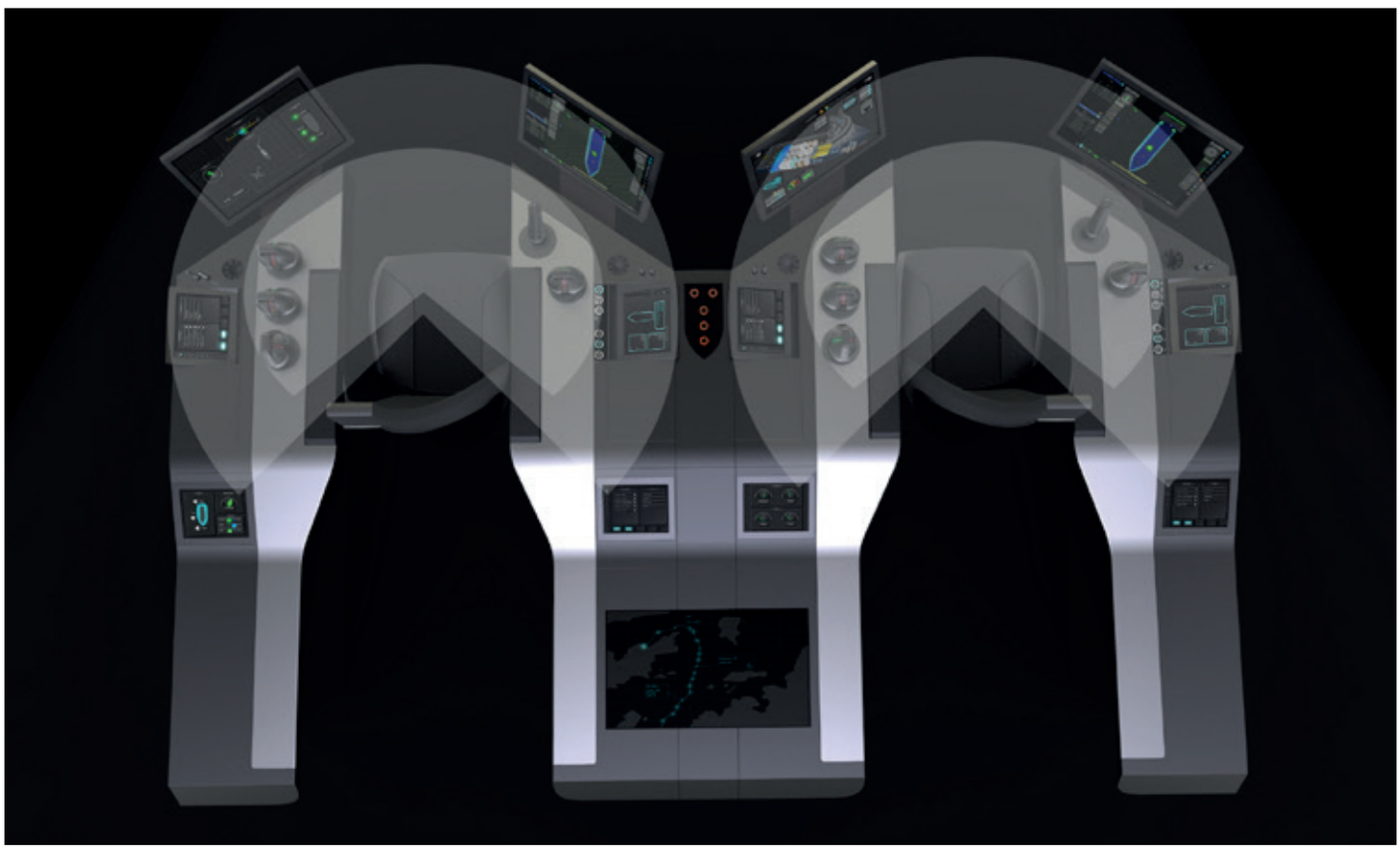
Modularity enables systems to be optimised for a range of vessel types including offshore, merchant, fishing and tugs. Third party products can be interfaced, accessed and operated using the Acon Bridge Control touch screen.

An offshore supply vessel is one of the more complex examples, with two stations and bridge wing consoles. A forward facing transit station focuses on ship control and navigation. There are two operator chairs on rails, one on each side of a centre console, and outside each chair is an outer console. This open-fronted layout gives the watchkeepers an optimal view. The joysticks and control levers are positioned so that the operator can work comfortably from a standing or seated position. Essential data such as the radar picture and electronic charts are displayed on large touch screens while other systems are monitored and controlled from a series of smaller touch screens located in the consoles. The setup is flexible so that different screens can be used for different systems and functions as the operators prefer. As most functions are accessed via touch screens, the number of buttons mounted on the consoles has been greatly reduced. Those that remain are typically those where push buttons and indicator lights are either mandatory or desirable, for instance fire alarms. Main controls and screens are also located in consoles on the bridge wings.

The aft facing station focuses on dynamic positioning and anchor handling operations and safe transfer of cargo to rigs and platforms.

Unified Bridge collects the controls and status information for all these systems and presents them to the ship operators in a clear and logical way, helping to reduce fatigue, prevent mistakes and misunderstandings and so improving safety at sea.

Human factors



When developing the ergonomics of the Unified Bridge we carried out realistic studies in our ship simulator using state of the art eye tracking equipment. We ran holistic bridge evaluations comparing interactions between operators and equipment and tested concepts and novel software.

Consoles and seat heights are chosen to comply with classification rules and to the ergonomic standards for normal working area and a wide unobstructed field of view. Control levers are located in the consoles to allow comfortable operation either standing or seated and the front end of the consoles is angled to give a natural wrist angle where the operator has to maintain a static position for long periods, for example during winch operations. All screens and other items that need to be accessed are within easy arm's reach.

The 'unified look and feel' philosophy is applied to all of our new software applications, interfaces are consistent, with a common way of navigating across systems, the same alert philosophy and a common way of switching between systems. This gives the user full overview and control.

We have developed control levers through several generations. They fall easily to hand and can now be delivered motorised to give tactile feedback, as well as having clear indication of position. Levers and joysticks are optimised for application, such as thruster and propulsion control, dynamic positioning (DP), crane control and multiple levers for simultaneous operation of up to three winches.

The devices all share the same design philosophy, physical footprint and common bus interfaces. Contactless potentiometers replace mechanical versions, preserving greater measurement accuracy over time. Push buttons, displays and indicators are integrated in the devices and tailored to the specific system they are controlling. Design is based on isolated dual electronics and sensors enabling devices to be connected to two different systems simultaneously with galvanically isolated communication lines. In the case of propulsion and thruster controls the levers can be connected independently to both the main and the backup system. Likewise, the DP joystick can be connected separately to both the DP and independent joysticks.

Operator's chair

The operator's chair is supplied either to slide between consoles, where controls and armrests are located on the consoles in the Unified Bridge, or as a freestanding unit, the Unified Chair with controls and screens in the armrests. Basic design of the chair is the same, with focus on a full range of adjustments to suit different body shapes and sizes, and comfort when occupied for long periods. Upholstery combines leather and alcantara for hard wear and freedom from clamminess. The narrow backrest design gives support but it is easy to move about or turn around.

Padded armrests have integrated tracker balls and a touch screen display. A standard arrangement for operator devices and panels is included, close to the user, angled for optimal wrist alignment and laid out for maximum comfort and minimum strain.

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1. Winch speed and tension control
2. DP joystick
3. Propulsion and azimuth control
4. Helmsman and rudder control
5. Tunnel thruster control

Dynamic positioning

Icon DP is a range of dynamic positioning systems from Rolls-Royce. We supply complete systems that meet the positioning requirements of many types of vessel that are equipped with suitable propulsor/thruster arrangements, from simple systems to those meeting the strictest redundancy requirements.

These DP systems are made up from two main elements – one is the Icon DP control system that takes information from position reference systems such as DGNSS, and laser radars, processes it, and issues commands to the propulsors and thrusters to move the vessel to the desired position and heading, then ensuring it is held against the forces from wind, waves and current trying to drive it off station. The other element is the Icon DP operator station, the effective and functional interface between the operator and the system, designed to simplify DP operations and to bring the system physically closer to the operator, enhancing both performance and safety.

Icon DP uses the Rolls-Royce Common Control Platform system architecture, hardware and software.

DP classifications

We engineer systems to meet the needs of the vessel, from the simple to those satisfying any of the IMO DP classes.

There has been a continuous development of positioning systems over the past 40 years, from simple joystick control, followed by the operator chair, and DP. Our first system meeting IMO DP2 were delivered in 2006. By 2012 over 100 vessels were sailing with Rolls-Royce DP systems. DP was integrated in the new Unified Bridge, with the first vessel having this high level integration and human-machine interface entering service in 2014.

Much of our production is of IMO DP2 systems, with an increasing number of DP3 installations.

Award for interaction design and user interfaces

The Unified Bridge and Icon DP has been awarded the Norwegian Design Council 2015 award for design excellence. The awarding jury said: “In a conservative business with many class regulations, it is a challenging task to develop innovative solutions for user interfaces. This solution appears significantly better than competing solutions, and the quality of the interaction design is high. The user interface is based on modern navigational principles. The work surfaces are layered, which enable navigation on one surface, and with the touch screen reduces cognitive load for operators.”

AWARD FOR DESIGN EXCELLENCE

The latest introduction is DP2+. This provides even higher levels of availability by giving the ability to maintain DP2 class requirements even after a single worst case failure. Icon DP2+ supports full 3-split power bus designs. There is an additional operator station making three in all, three main DP controllers running in triple redundant configuration, four separated powered sensor groups and IO groups, a dual network ring and also the option of dual independent joysticks.

DP2+ can be extended to provide positioning to DP3 rules with a very high level of redundancy. In this case a DP2+ system is extended by the addition of a single stand-alone back-up DP.

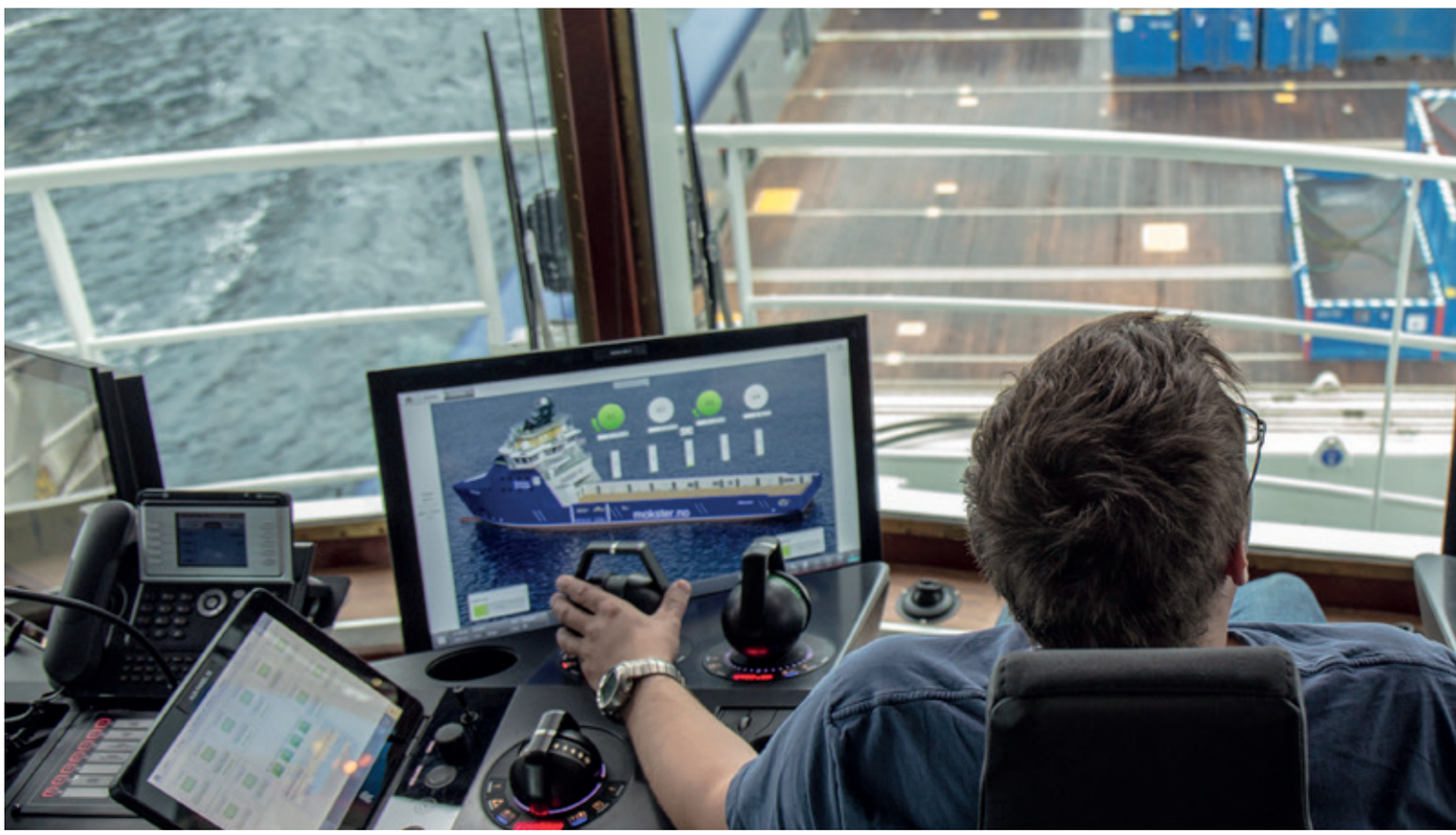
Typical applications:
(for all vessels with suitable thruster/propulsor arrangement)

- Offshore support vessels/ Anchor handlers
- Subsea construction vessels/Drilling vessels
- Yachts
- Work boats/Tugs
- Heavy lift
- Windmill installation and support vessels

Key product benefits:

- Sophisticated thrust allocation
- Way-point tracking
- Follow ROV
- Follow Barge
- Pipeline inspection mode
- Pipe lay and cable lay
- Eco positioning
- Online capability analysis
- Motion prediction
- Built-in trainer
- System logging
- Playback

Propulsion and thruster control



Rolls-Royce provides systems and equipment for control of propulsion, from the human machine interface with levers and screens on the bridge and in the control room, to control and monitoring of diesel and gas engines, propellers, waterjets, thrusters and steering gear. Complex systems such as diesel electric, gas electric and hybrid propulsion are catered for.

Propulsion, thruster and steering control provides the operator with a clear picture of the propulsors and thrusters in use at the time, with magnitude and direction of thrust shown pictorially and numerically. When used in integrated solutions (Unified Bridge) the screen may be shared with the Poscon joystick and the Icon DP systems. Three situations can be called up on one screen, giving the operator a clear appreciation of status.

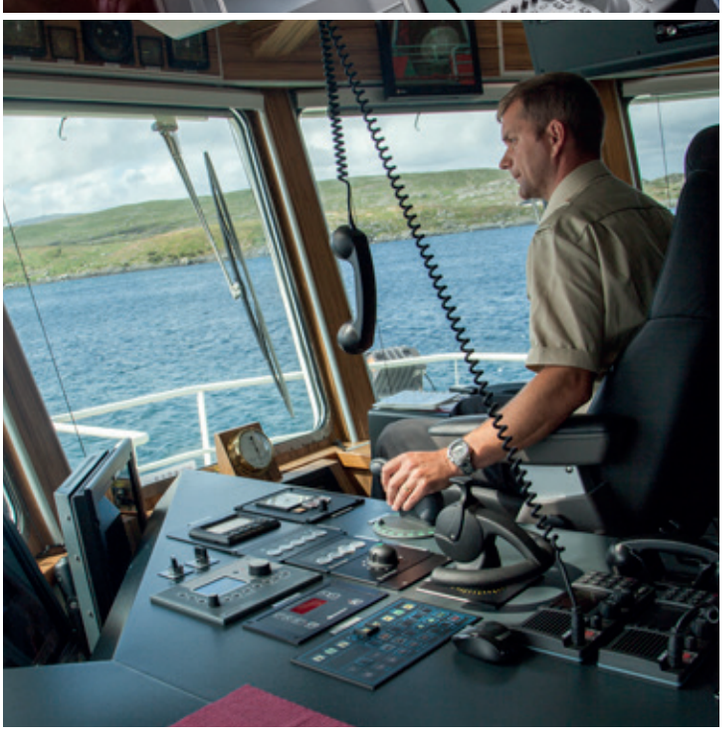
Systems are designed to give the operator intuitive control of propulsion. Control levers and the operation panels and the underlying control architecture are optimised for the various applications of propulsion systems, but always based on the

Key product benefits:

- Easy and safe operations
- Ergonomic design
- Possibility of redundant control systems
- Seamless integration in the Rolls-Royce Unified Bridge and with other Rolls-Royce equipment

Typical applications:

- Offshore service/support vessels
- Yachts
- Work boats/Tugs
- Drilling vessels
- Heavy lift
- Windmill installation and support vessels
- Patrol vessels
- Cargo vessels



Azimuth thruster tugs and waterjet propelled patrol vessels boats are just two examples of vessel types where Roll-Royce provides control systems that are intuitive to use, with control levers and information displays that are ideal for the application.

Rolls-Royce Common Control Platform and standard hardware and software modules.

For offshore vessels and others with multiple propellers and thrusters for propulsion, and retractable and tunnel thrusters for manoeuvring/positioning, our control systems and control levers have follow-up and ergonomic design and integrated push buttons for all key functions including command transfer, alarm acknowledgement and selection of back-up control. The screen gives the operator a clear view of status of the propellers and thrusters with system warnings, alarms and soft buttons for operating main functions. Separate views of each propeller or thruster can be called up for more detailed information on functions and settings. Propulsors with variable pitch and revolution have combinators for these parameters programmed to suit the specific vessel.

For vessels such as azimuth thruster tugs, control levers are comfortable to operate standing or sitting, and can be specified with or without follow-up.

Waterjet propulsion is chosen for a wide variety of fast commercial, paramilitary and naval vessels. The control systems are configured to suit the vessel, its waterjet arrangement and its operation, but based on the Common Control Platform with standardised hardware and software modules. Multiple waterjets, steerable/reversible or boost, can be controlled by a single joystick in both transit and manoeuvring modes. We supply optimised systems for the bridge of large fast ferries, specialised vessels, and smaller high speed craft with lively motions in a seaway where the operator will be strapped in a suspension seat.

Ship automation

Acon is our newest generation of automation systems (IAS) designed to control and monitor ship operational systems and equipment. Acon IAS ensures a robust, flexible, modern and reliable ship environment.

Acon is built on our standardised software and hardware platform called Common Control Platform (CCP) which ensures seamless software integration, efficient upgrades and access to spare parts. It is scalable and comes as a multipurpose integrated solution, or as a standalone system. It can be connected to the Rolls-Royce Ship Integration Network for easy information sharing between shipwide systems and equipment.

Designed for usability the operator interface is tailored to the ship and gives access to the underlying ship systems through an ergonomic standardised interface specifically designed for easy and safe operation.

Multifunctional displays allow the operator to choose which information is to be collected and presented together, while class defined critical information is displayed at all times.

The Acon IAS has a redundant system architecture. Distributed IO cabinets and redundant Rolls-Royce controllers communicate on a redundant network connected to independently working operator stations, offering a high level of safety against breakdown.

Acon automation covers a range of functions including the status of machinery, the management of electric power generation and distribution of tank contents with gauging and pumping systems. Apart from providing the operator with information via the graphical user interface, and through the structured audible and visual alarm system, Acon automation is also the basis for data logging. Logged information can be used to improve maintenance planning, reduce machinery running hours and general wear and tear and when combined with data transfer it can improve fleet management.

We offer several Acon products as stand-alone sub-systems or at various levels of system integration.

With LNG becoming more important as a marine fuel, our Acon LNG control system covers bunkering, control of gas supply to engines plus alarm and monitoring functions warning of gas leakage. All regulatory requirements for emergency shut down are handled by the Acon system.

Bridge control

The Acon Bridge Control (ABC) system provides additional control for auxiliary systems like wiper, lanterns, deck ligths, bridge ligths, common dimming etc. The system is built around the concept of moving functionality closer to the operator by integrating auxiliary bridge equipment functionality into a common user interface and corresponding panels can be moved from the consoles to a dedicated area for manual control. The system also provides a uniform way of interacting with different technologies and opens up more space for placement of important main operational equipment.

The system integrates the appropriate functionality from each interfaced system. Original auxiliary systems should not be modified to suit the ABC system; original user interfaces shall be available at the manual control station/manual equipment station. A malfunction in the ABC system shall not affect the interfaced systems and malfunctions in the integrated systems shall not affect the ABC system. In case of malfunction or error, the operator will be informed through audible and visual alarms.

The Acon Bridge Control home screen will give you a complete overview of alarms and bridge activities.

Bridge navigation watch and alert system

The Acon Bridge Navigational Watch system (BNWAS) helps to prevent marine accidents.

It monitors bridge activity and detects operator disability during one-man bridge operation. BNWAS meets NAUT-OC/AW, NAUT-OSV, IMO MSC.128 and IEC 62616 requirements.

The Acon Central Alarm Management system (CAM) gives audible and visible navigation, watch or distress warnings on the bridge which can be silenced from the operator panels. If no action is taken the alert situation may be escalated via the BNWAS. CAM meets NAUT-OC/AW, NAUT-OSV and IMO MSC.302 requirements.

BNWAS/CAM is designed to be connected to a voyage data recorder (VDR).

The Acon BNWAS/CAM alert screen will give you a complete overview of bridge alert status.

Key product benefits:

- Dual redundant network and controllers
- Single control point for multiple products
- Better overview of ship process systems and equipment
- Unified look and feel
- Distributed IO system
- Supports 2 and 3 zone split
- Energy module supports user with CEEMP/SEEMP compliance

Alarms, control and monitoring

LNG – ESD

The Acon LNG control system covers both the supply of gas at the correct temperature and pressure to the engines, and also bunkering operations, as well as onboard LNG tanks. Sensors at key points including the double wall gas pipes give warning of any leakage. The screen gives the operator full information on system status.
In the event of problems with the LNG equipment the emergency shut down (ESD) system in the Acon automation will render the storage and supply safe, meeting classification society and other rules.

Power management

Acon Power Management provides full control of the ship's electric power distribution system. It gives the operator information and control over power consumption, power capacity and power generation. Easy operation and equalising of power load demand and capacity is also ensured.

A winch interface is available, of special importance for offshore anchor handlers. Winches are among the largest power consumers and the most stability-relevant equipment on this type of vessel. Full interfaces with winch equipment ensure a complete proactive approach to power management and ship stability.

Tank sounding system

The ship's tank level sounding system. Electropneumatic tank equipment, in addition to electronic and radar sensors, is used for level measuring. The data is then processed and transferred to the operator stations where the tank information is easily configured and monitored.

Control

The ship's control system for pump and valve operations including cargo handling and machinery systems.

The customised mimic diagrams provide easy operation via an uncluttered overview of the ship's systems and its resources. Processes can be tailored to be fully automated.

Alarms

Acon alarm continuously surveys machinery and systems and gives audible and visual warning of equipment failure, off-limits situations or where equipment has exceeded stipulated maintenance intervals. Alarms are structured and presented in a logical way. The operator can see the current alarms listed on the central screen on the bridge and control room, together with current values of the measured parameter, gaining a quick appreciation of the severity of the alarm situation.

Machinery

The monitoring systems display information on the engines and propulsion system. This includes oil and water temperatures and pressures, exhaust temperatures, engine powers and loads. Individual engines and propulsors can be called up for full overview of operating data.

Energy management

An online portal to view, record and compare energy efficiency performance of your fleet; focusing on fuel consumption, emissions and operations.

We know our customers are interested in reducing energy consumption and becoming more environmentally friendly. Also, that in some geographical areas it is necessary to have an energy monitoring system in order to meet industry regulations, and in other areas it is a feature which earns extra points during negotiations for charter contracts.

To meet these requirements, the Rolls-Royce Energy Management system captures data on board, transfers the data ashore, processes the data and reports the data via a web portal. The web portal allows customers, wherever they are in the world, to view detailed energy consumption of their vessels that are equipped with the Energy Management system. The information in the portal is updated on a daily basis.

Individual vessel reporting is available, showing an overview of vessel operational mode, equipment running hours and fuel consumption of each operational mode. It is possible to view the historical trends of vessel operational data for each operational mode. Fleet reporting allows customers to make comparisons across their fleet, for example, to see which vessels are operating most efficiently and to identify areas for energy efficiency improvement. Furthermore, the system gives customers an easy method of providing evidence to comply with emissions regulations, and enables customers to verify their return on investment in efficiency improvement measures.

This system from Rolls-Royce is suitable for all types of vessels, and can be installed while the vessel is under construction or as an upgrade to a sailing vessel. We can also install the system on vessels with equipment from both Rolls-Royce and other suppliers. Energy Management is offered as a service. Customers purchase the hardware and software, and once this is installed, access to the web portal is available by annual subscription.

Key product benefits:

- Identifies opportunities for reducing fuel consumption and exhaust emissions
- Conducts comparisons to reduce operating costs
- Produce evidence of compliance with emissions regulations
- Assesses and verifies efficiency improvement measures through actively quantifying performance
- Supports user with CEEMP/SEEMP compliance
- Accesses Rolls-Royce expertise for advice on suitable efficiency upgrades
- Runs time per engine and per propeller, for each operational mode
- Energy efficiency index
- UREA consumption
- Vessel statistics comparisons

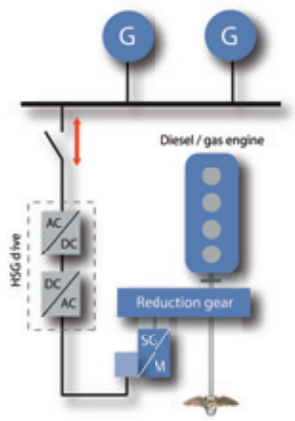
Improving ship efficiency

The key issues for operators today are fuel consumption and emissions. These are also the comparison criteria used by an increasing number of charterers in vessel selection. With the introduction of Ship Energy Efficiency Management Plans, operators need a clear view of how much energy their vessels use, and the evidence to back it up. The crew on board also need good information on energy consumption so that with the help of Rolls-Royce systems they can run their ship most efficiently.

We have developed new electrical solutions to improve overall energy efficiency and operating flexibility, including hybrids for different applications with batteries or supercapacitors as part of the system.

For vessels with mechanical drive to CP propellers the Rolls-Royce HSG system can give a welcome boost to efficiency. It allows constant frequency electrical supply to be maintained even when engine and propeller speed is varied to provide the best propeller and engine efficiency under different operating conditions. Where a vessel works in several distinct modes needing different levels of propulsion power, the electrical machine on the gearbox can function either as a shaft generator or a motor fed with power from gensets, ensuring that only the engines that are necessary are run, and run at their point of lowest fuel consumption. HSG is also an effective interface to shore power, supplying the voltage and frequency needed by the ship even when the shore network specification is different, and eliminating local pollution from running generator sets on board.

Our Active Front End tranformerless AC/DC/AC converter systems allow energy storage devices; batteries and supercapacitors to be included to buffer short term power demand fluctuations, for example on vessels in DP mode, to provide power boost, allowing combustion engines to run at more constant and fuel-efficient power levels. Vessels with large winches and heave compensated cranes can benefit from feeding back power from winches or cranes into the system to cut primary energy demand. The energy storage devices can either be feeding the main switchboard or locally at the large consumers.

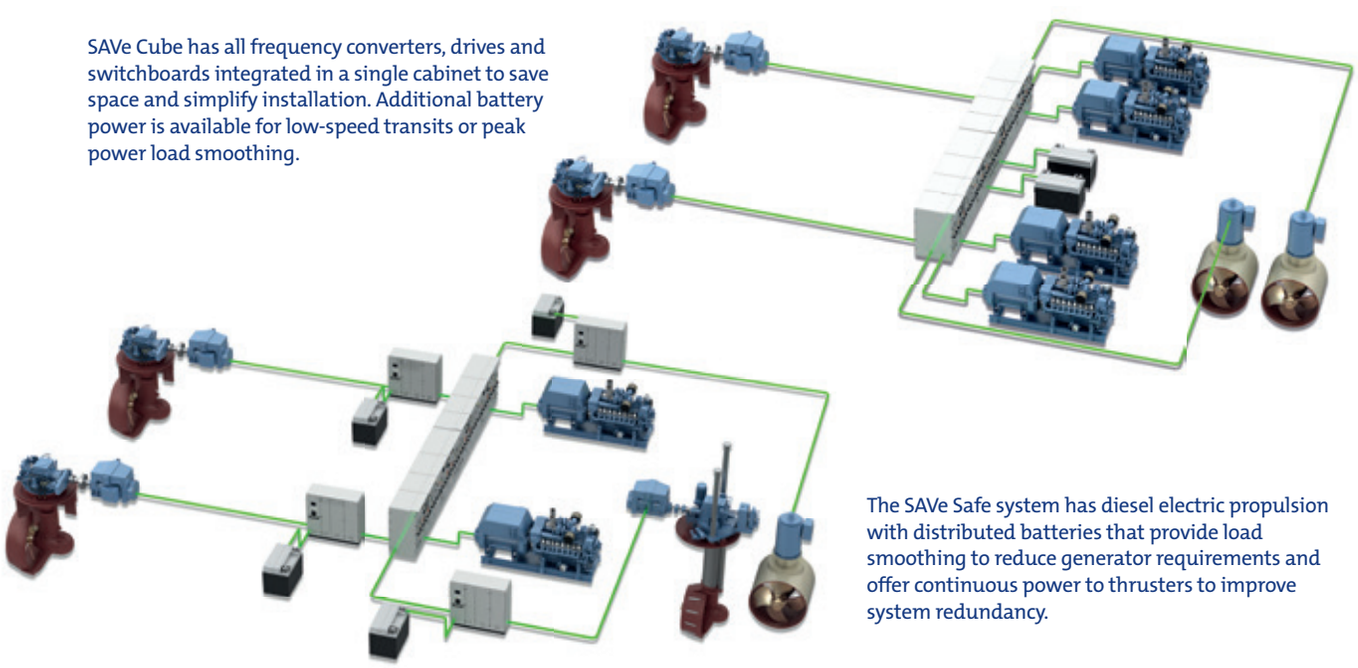


HSG gives fixed frequency power from a variable speed shaftline, or electric drive to the propeller by genset for energy efficiency in different vessel operating modes.

We are also providing vessels with energy saving systems under the SAVe label. These are integrated propulsion solutions that can be optimised for different operational modes on a wide range of vessels, saving fuel and cutting emissions. They can be powered by high-speed and medium-speed engines, diesel or gas, running at fixed or variable rpm and delivered with complete control and monitoring systems.

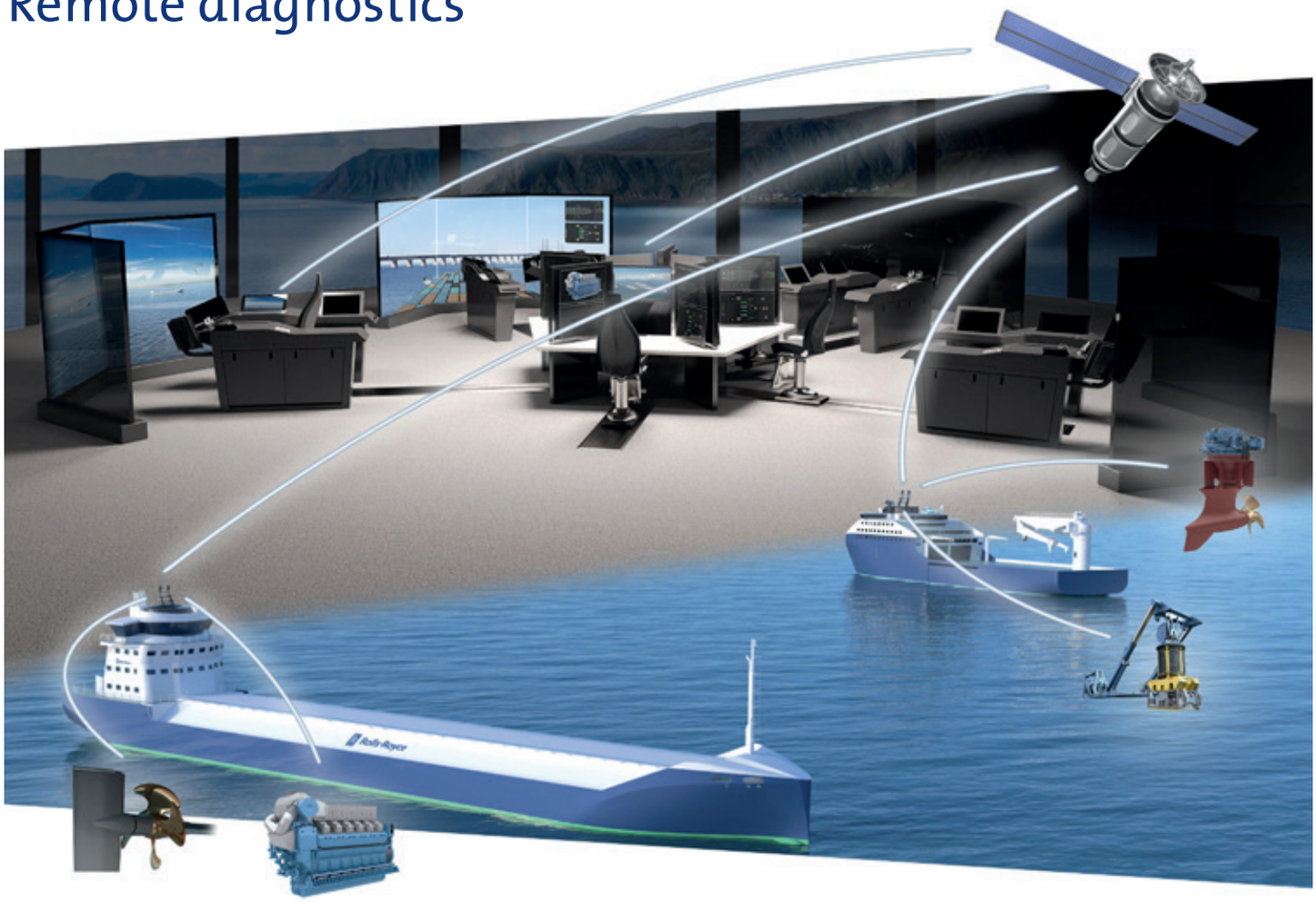
Rolls-Royce control and automation looks after all these systems and provide the crew with clear information enabling safe and effective operation.

SAVe Cube has all frequency converters, drives and switchboards integrated in a single cabinet to save space and simplify installation. Additional battery power is available for low-speed transits or peak power load smoothing.



The SAVe Safe system has diesel electric propulsion with distributed batteries that provide load smoothing to reduce generator requirements and offer continuous power to thrusters to improve system redundancy.

Remote diagnostics



It is crucial that our customers can always count on our reliable support. Therefore Rolls-Royce is introducing Remote Access, a tool that enables our engineers ashore to remotely access the Rolls-Royce systems on board a vessel to give operational support and guidance, inspection of on-board systems and interfaces and preparation and investigation prior to service visits. It also enables our service teams to fully understand the problems and be better prepared for service attendance.

To ensure a secure connection at all times, remote access creates an encrypted VPN connection from our engineer's computer to the vessel. From anywhere in the world, via an internet connection which can be 3G, 4G, GPRS, VSAT or EDGE, the VPN's encryption allows access to the vessel's Rolls-Royce control systems in a safe and secure manner. Access must be physically granted by the vessel's crew for Rolls-Royce to be able to use remote access.

Once a safe connection is established, maintenance and troubleshooting can commence in cooperation with the crew.

The main benefits of remote access include reducing the need for costly on-site service visits and provision of everyday trouble-shooting assistance, leading to reduced vessel downtime. This is a secure solution through safe and reliable connections, and also because total control of the procedure remains with the ship's crew, who decide when to activate the system.

With remote access we can find system faults, download log files, and inspect the systems' health, allowing us to offer advice on preventive maintenance.

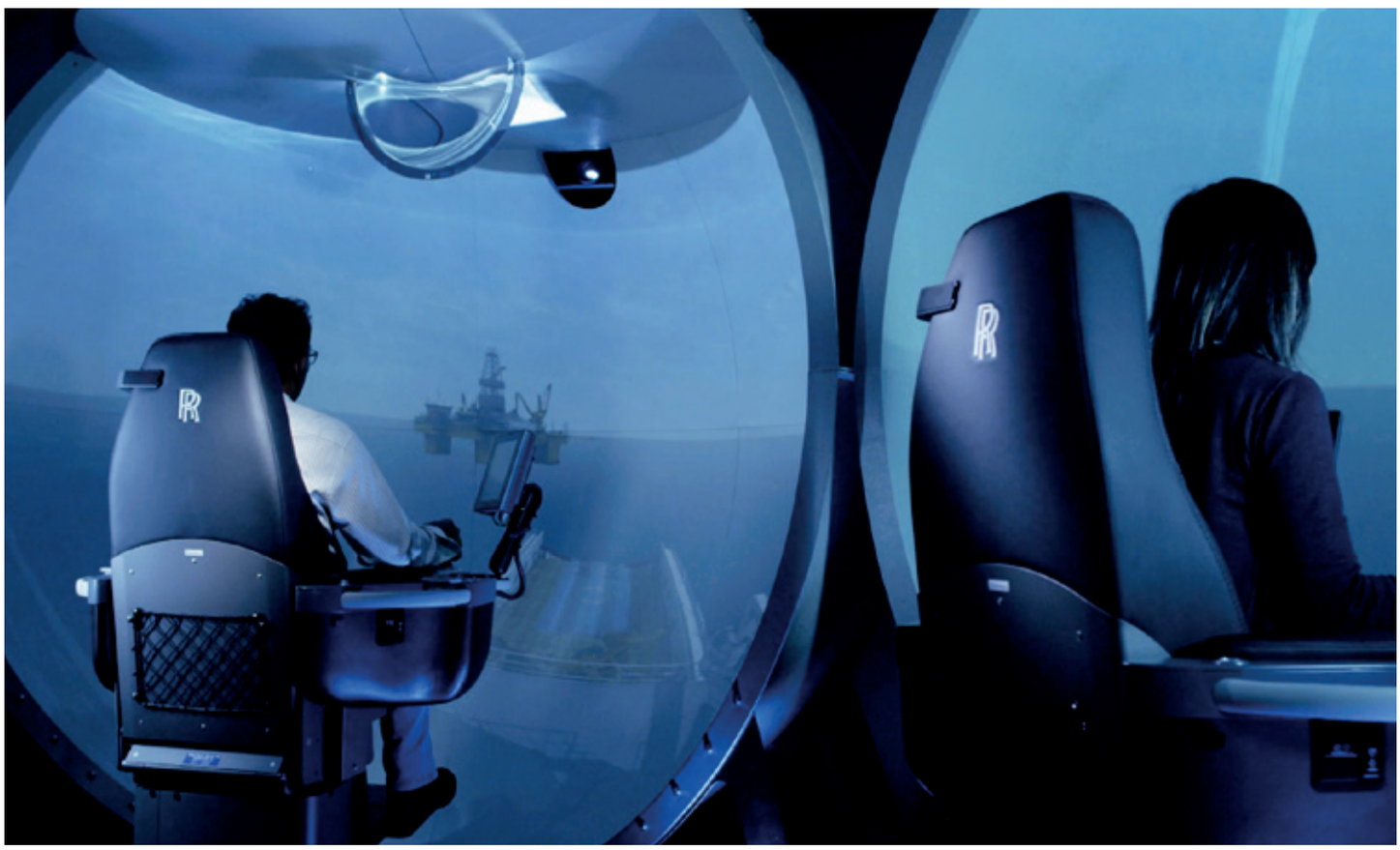
When needed we can download the systems' software for inspection and adjust some of the systems' parameters and limits.

Remote access available on the following products:

- Propeller and thruster controls
- Icon DP
- Acon automation
- Towcon
- Winch drive system
- Synchro RTX Autotrawl
- Energy Management system
- Switchboards
- Black Out Prevention system
- Power Management system
- Propulsion drive system
- Auxiliary drive system
- Electrical motors
- Generators

Typical applications:
Remote access can be installed on any new vessel, but also as an upgrade on older vessels, as long as they are equipped with any Rolls-Royce automation and control product.

Product training



Any ship is made up of a large number of systems. The crew needs to understand how these systems work and interact if they are to operate the vessel safely, and also if they are to operate it at the highest level of efficiency with minimum wear and tear or equipment failures.

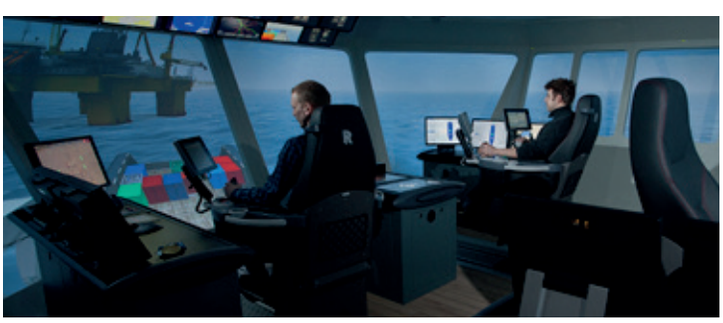
To help crews achieve high standards of competence Rolls-Royce offers a wide range of training courses on products and their associated control and automation systems. Our main objective is to optimise our customer`s operations on all Rolls-Royce equipment through the delivery of world class, innovative training offerings, which serve to reduce operational risk and downtime, improve safety, meet regularity standards and maximise customer´s return on investment.

Typically, the courses cover operation with time in simulators where appropriate, troubleshooting and maintenance using classrooms, technical rooms and workshops fitted out with real equipment for hands-on maintenance instruction.
We also provide tailormade courses to shipowners to enable them to train their crews in the operation of their new Rolls-Royce designed or equipped vessel.

The majority of our training courses take place in Ålesund, Norway, at the Rolls-Royce Technology & Training Centre. Here are experienced instructors, simulators, workshops and classrooms for theoretical and hands-on training in operation and maintenance of systems and products. Well-equipped regional training centres have also been established in Niteroi, Brazil, covering South America, and in Singapore covering Asia.

We offer training on the following systems:

- Dynamic positioning
- Automation systems
- Engine and propulsion controls systems
- LNG systems including LNG safety management
- Winch and towing systems



Global service and support

Our support teams, located worldwide, are committed to helping you manage the vital balance between operational availability and cost. Wherever your vessel is located, Rolls-Royce support is close at hand.

Today, operational availability must be maintained in the most cost-effective way. Variable market conditions and increasing competition should not undermine safe ship operations. Therefore, we work closely with our customers to support their fleets, ensuring that they are operating safely and at maximum efficiency, with the goal of virtually eliminating unscheduled downtime.

A comprehensive menu of service solutions

We are proud of the performance of our systems, and are keen to ensure that they continue to operate at their peak throughout their lifetime. Our services now range from conventional product support, with no impact on ship availability, through to a range of equipment and system support packages with levels of vessel performance and availability agreed, normally within a long-term risk and reward-sharing partnership called MarineCare.

Single point of contact

As we have progressively increased the breadth of our product range, we have continued investing heavily in the facilities and the talent needed to support them. As multiproduct installations are becoming standard on a growing number of vessels, customers benefit from a single point of contact for support, which is usually the nearest Rolls-Royce regional centre to the vessel's location.

Reducing through life costs

Reducing operating costs and maximising availability is our objective. This has led us to work closer with a number of our customers in maintenance planning and recommending spares holding. By being involved from the start we have the opportunity to focus on the activities that make a difference, acquiring and pre-positioning service or exchange parts to ensure a smoother overhaul process, saving time spent in dock.

Committed to meeting different needs

Above all, at the centre of our support philosophy, is recognition that all customers have different and often unique requirements, based on their fleet operations. Whatever the mix of requirements, Rolls-Royce is committed to meeting or exceeding them.

Upgrades

Many Rolls-Royce products are designed to remain in service for several decades. To ensure these products maintain the highest levels of operational safety, reliability and productivity, we provide a range of equipment upgrades as part of our lifecycle management plans.

Older vessels with earlier generation equipment can therefore benefit from advances in technology so that they remain competitive in their markets.

Automation and control upgrades include updating of automation systems and user interfaces to take advantage of latest human factors thinking and hardware/software advances, and also upgrades of dynamic positioning (DP) systems.

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