DYNAMIC POSITIONING: WHAT IS IT AND HOW WE CAN ASSIST?

By Stuart Duffield

As the offshore energy industry continues to evolve, and operations become more complex, the demand for reliable and safe DP systems has never been more critical. At TMC, we understand the complexities and challenges of maintaining optimal DP operations.

DYNAMIC POSITIONING (DP) SERVICES OVERVIEW

Dynamic positioning systems are integral to modern marine operations, enabling vessels to maintain their position, and manoeuvre, in challenging environments. Whether it's for drilling, construction, or accommodation purposes, the reliability of DP systems is paramount.

TMC offers a comprehensive suite of DP services designed to support all aspects of DP operations, from the initial design and analysis to ongoing assurance and incident response.

DYNAMIC POSITIONING

The principles of Dynamic Positioning are the same regardless of the manufacturer, type of system, hardware type and complexity of vessel. A DP system controls a vessel's position and heading automatically.

The Dynamic Positioning (DP) can be described as an integration of several shipboard systems to obtain the ability of accurate manoeuvrability. DP can be defined as: "A system which automatically controls a vessel's position and heading exclusively by means of active thrust".

The above definition includes remaining at a fixed location, but also precision manoeuvring, tracking and other specialist positioning abilities. A convenient way of visualizing the inter-relation of the various elements of a DP system is to divide the system into six parts, as the following figure shows.

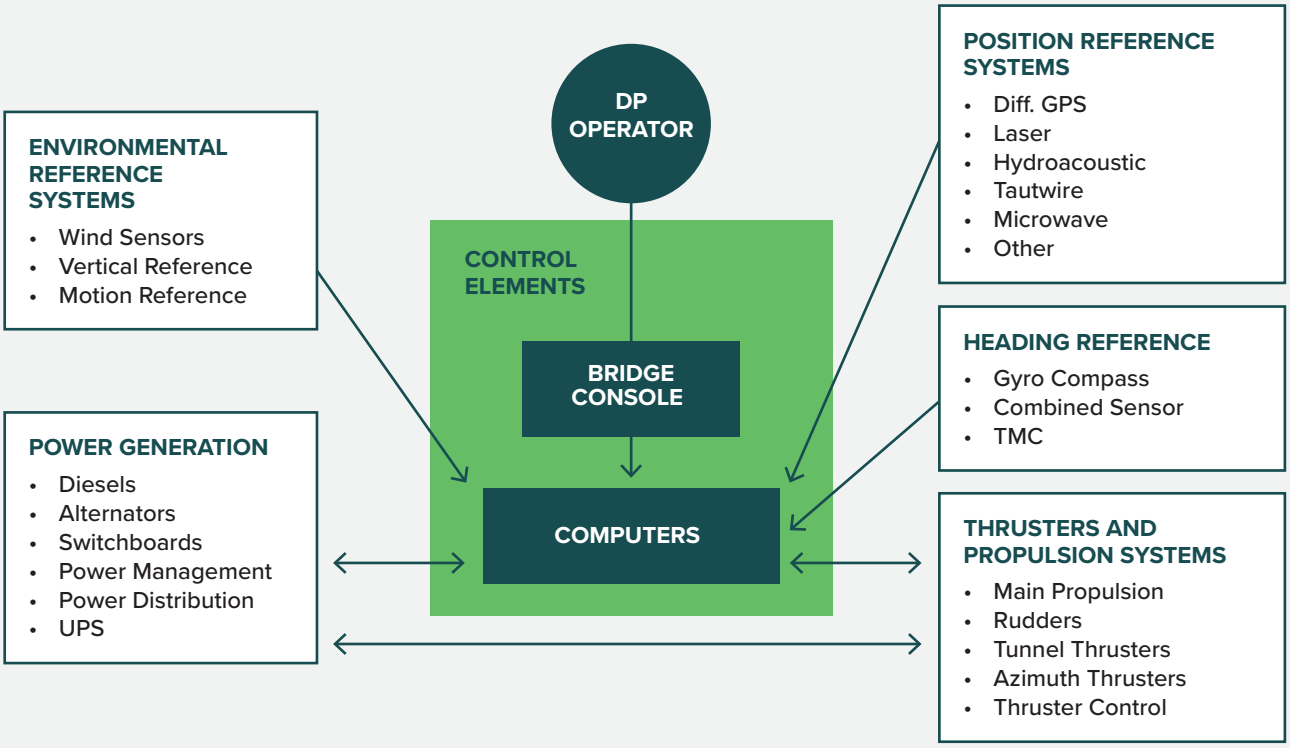
The prime function of a DP system is to allow a vessel to control and maintain a set position and heading. A variety of further sub-functions may be available, such as track-follow, follow-sub etc., but the control of position and heading is fundamental.

However, within the DP system installed on the Vessel, priority is given to the maintaining of the Vessel heading. Thus, if position and heading excursions occur simultaneously, the system will prioritise the reduction of heading deviation.

The DP system relies on a mathematical vessel model which is a mathematical description of how the vessel reacts or moves as a function of the forces acting upon it (such as current drag coefficients and virtual mass data). This model is a hydrodynamic description, called the Mathematical Vessel Model, and describes how the vessel responds to an applied force, e.g. from wind or thrusters. The main outputs from the model are filtered estimates of the vessel's heading, position and speed.

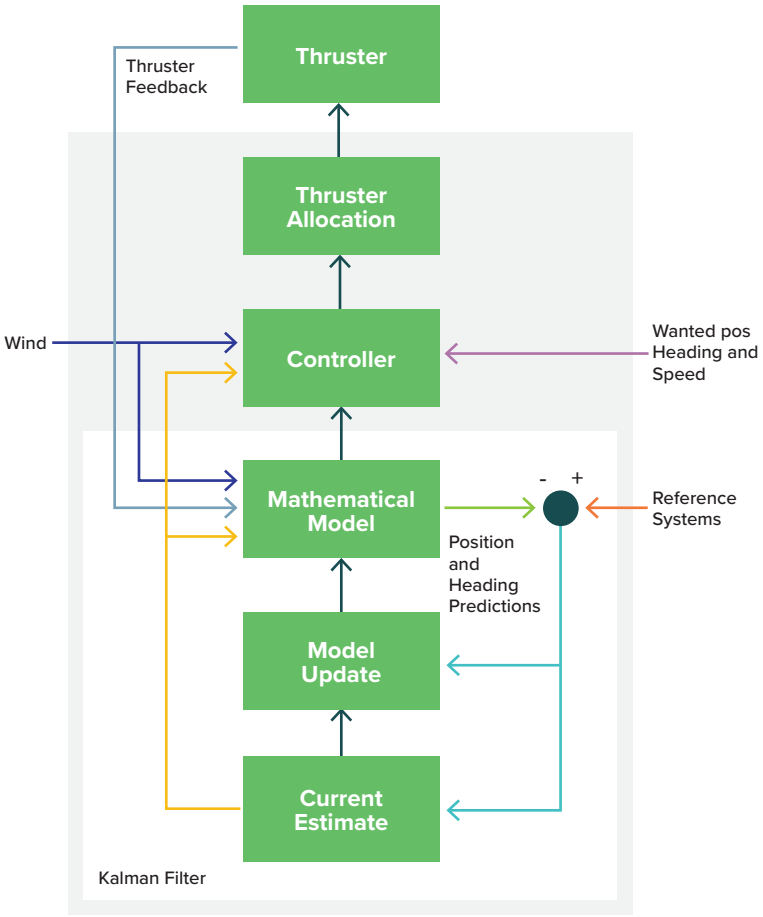
The model itself is never a 100% accurate representation of the real vessel. However, by using the Kalman filtering technique (as described below), the vessel model can be continuously corrected to increase its overall accuracy.

FIGURE 1: THE ELEMENTS OF A DP SYSTEM



The Extended Kalman Filter is a component of the vessel model that estimates the vessel's heading, position and velocity in each of the three degrees of freedom - surge, sway and yaw. It also incorporates algorithms for estimating the effect of sea current and waves.

FIGURE 2: MATHEMATICAL MODEL INCLUDING KALMAN FILTER



Every vessel is subjected to forces from wind, waves and tidal movements as well as forces generated from the propulsion system and other external elements. The response to these forces is vessel movement, resulting in changes of position and heading. These are measured by the position reference systems and gyro compasses.

The DP control system calculates the offsets between the measured values of position and heading, and the required (or set point) values, and calculates the forces that the thrusters must generate to reduce the errors to zero. In addition, the DP control system calculates the wind force acting upon the vessel, and the thrust required to counteract it based on the model of the vessel held in the DP software.

Modelling and filtering allow for a 'dead reckoning' or 'DR' capability (often called 'memory') to operate if all position references are lost. The vessel will continue to maintain position automatically, although the position-keeping will deteriorate with the increasing length of time since the last position data was received.

The modelling and filtering of the vessel position is only valid whilst the DP system has surge and sway selected as under control of the DP system. With just the heading selected in auto-mode in the DP system there is no capacity for the system to calculate the unknown forces acting upon the vessel. As such the vessel cannot be considered to be "in DP Mode" with just the heading under the DP system controller command.

CURRENT REGULATIONS AND REQUIREMENTS

Vessels fitted with Dynamic Positioning systems are subject to requirements from the class societies for DP class notation. This generally reflects the level of redundancy required for the systems installed on board. This can range from a “zero”, meaning that a single failure of critical equipment may result in the loss of position of the vessel through to class-3 systems, where a single-point failure will not result in the loss of position of the vessel, this includes the assessment for the risk of fire or flooding in a single compartment.

Whilst class requirements are well documented from the class societies, the dynamic positioning industry is self-regulated with numerous stakeholders providing guidance for all aspects of DP operations and requirements for assessment of the systems as installed to verify and assure that the DP systems are redundant, and the vessel capabilities match the project requirements.

Guidance is available from, among others, the International Marine Contractors Association (IMCA), the Marine Technical Society (MTS) Dynamic Positioning Committee and the Oil Companies International Marine Forum (OCIMF) Publications & Advocacy Offshore group. TMC personnel have, and continue to, provide input to these groups and be active within the industry and remain up to date with the latest advancements in the field of DP operations.

NEW BUILD SPECIFICATIONS AND SYSTEM DESIGN

TMC consultants have extensive DP vessel new build experience and can advise on new building specifications, equipment integration and DP system design.

FAILURE MODES AND EFFECTS ANALYSIS (FMEA)

At the heart of any DP services is the Failure Modes and Effects Analysis (FMEA). TMC conducts thorough FMEAs to identify potential failure points within a vessel’s DP system and evaluate their impact on overall operations. Our expert consultants work closely with clients and OEM’s to assess every component of the DP system ensuring that all potential risks are understood and mitigated where required.

By conducting an FMEA, we help vessel operators enhance the reliability of their DP systems, identifying the failures that could lead to costly operational downtime or accidents. This assists the vessel crew in their decision-making process during the operations being carried out.

Our FMEA reports provide actionable insights, enabling clients to prioritize upgrades and maintenance efforts where they are most needed, ultimately improving the resilience and performance of their DP operations.

GAP ANALYSIS

DP Gap Analysis is designed to identify discrepancies between a vessel's current DP capabilities and industry standards or client-specific requirements. Our experts can conduct a detailed examination of the DP system's design, performance, and operational history, pinpointing areas where improvements may be required to meet regulatory compliance, the latest guidance available, or to optimize performance.

This service is particularly valuable for clients looking to upgrade their DP systems or ensure compliance with the latest industry standards. By bridging the gap between current operations and desired outcomes, we help our clients achieve optimal DP performance, enhancing safety and operational efficiency in even the most challenging offshore environments.

DP OPERATIONS SUPPORT

Our services range from the initial planning and design phases to real-time operational support and post-operation reviews. We provide expert guidance on the selection and configuration of DP systems, ensuring that they are tailored to meet the specific operational requirements of each vessel.

During operations, our consultants are available to provide real-time support, helping operators navigate complex scenarios and respond to any issues that may arise. Post-operation, we conduct detailed reviews to identify any lessons learned and areas for improvement, ensuring that each operation builds on the success of the last.

ACCIDENT AND INCIDENT INVESTIGATION

In the unfortunate event of a DP-related accident or incident, TMC's expertise and expert investigators are on hand to provide a thorough and impartial analysis. Our investigation services are designed to uncover the root causes of incidents, whether they stem from system failures, human error, or external factors.

We utilise state-of-the-art tools and methodologies to reconstruct events, analyse data, and interview key personnel. Our reports provide a clear and concise explanation of what went wrong, along with recommendations for preventing similar incidents in the future. Our investigation services not only help clients resolve immediate issues but also contribute to the broader goal of improving safety and reducing risks in the offshore industry.

MARINE ASSURANCE SERVICES

TMC marine assurance services encompass a wide range of activities designed to ensure the safety, reliability, and compliance of vessels operating with DP systems. From pre-operations audits to ongoing monitoring and evaluation, our assurance services provide clients with the confidence that their DP systems are operating at peak performance.

Our assurance services include regular audits of DP systems, compliance checks against industry standards, and performance evaluations. We also offer bespoke assurance packages tailored to the specific needs of individual clients, ensuring that all aspects of DP operations are covered.

EXPERT WITNESS SERVICES

All of the above makes us a trusted partner for legal professionals and insurance companies. Our expert witness services are relied upon in legal disputes and arbitration cases, including those involving DP systems. We provide objective, technically sound testimony that helps clarify complex issues and supports fair resolutions.

Our consultants have extensive experience in both the technical and legal aspects of marine operations and DP systems, enabling them to provide clear and compelling evidence in court or arbitration settings. Whether representing P&I clubs, vessel operators, or energy companies, our expert witnesses bring credibility and insight to every case.

TAILORED SOLUTIONS FOR THE OFFSHORE ENERGY INDUSTRY

TMC's DP services are trusted by energy majors, P&I clubs, law firms, and vessel operators across the globe. We understand that every client has unique needs, and we are committed to providing tailored solutions that address the specific challenges of each project. Our deep expertise in dynamic positioning, combined with our commitment to excellence, ensures that our clients receive the highest level of service, whether they are seeking to enhance operational efficiency, improve safety, or resolve complex legal disputes.

CONCLUSION

As the offshore energy industry continues to push the boundaries of what is possible, the need for reliable and expert dynamic positioning services is greater than ever. TMC is proud to be a leading provider of bespoke DP services, offering our clients the expertise, insight, and support they need to succeed in this challenging environment. Our comprehensive suite of services, from FMEA and gap analysis to incident investigation and expert witness support, ensures that our clients can operate with confidence, knowing that their DP systems are in the best possible hands.

Whether you are an energy major, a vessel operator, or a legal professional, TMC is your trusted partner in navigating the complexities of dynamic positioning in the marine industry.

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