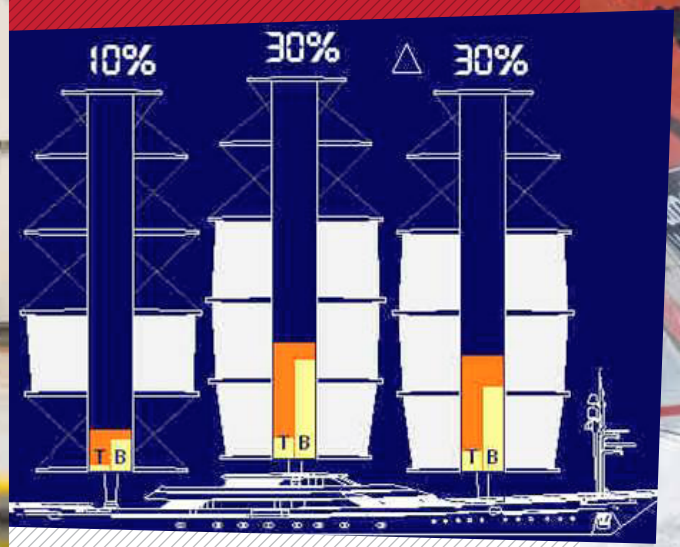
ADVANCED FIBRE OPTIC MONITORING



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UNIQUE CHALLENGES: ENGINEERED

innovative solutions in composites to meet a complex array of design challenges

Combining pioneering experience in fibre optic strain technology with composite design and manufacturing excellence to deliver bespoke and reliable load monitoring solutions for structures as well as performance enhancing monitoring for racing yachts.

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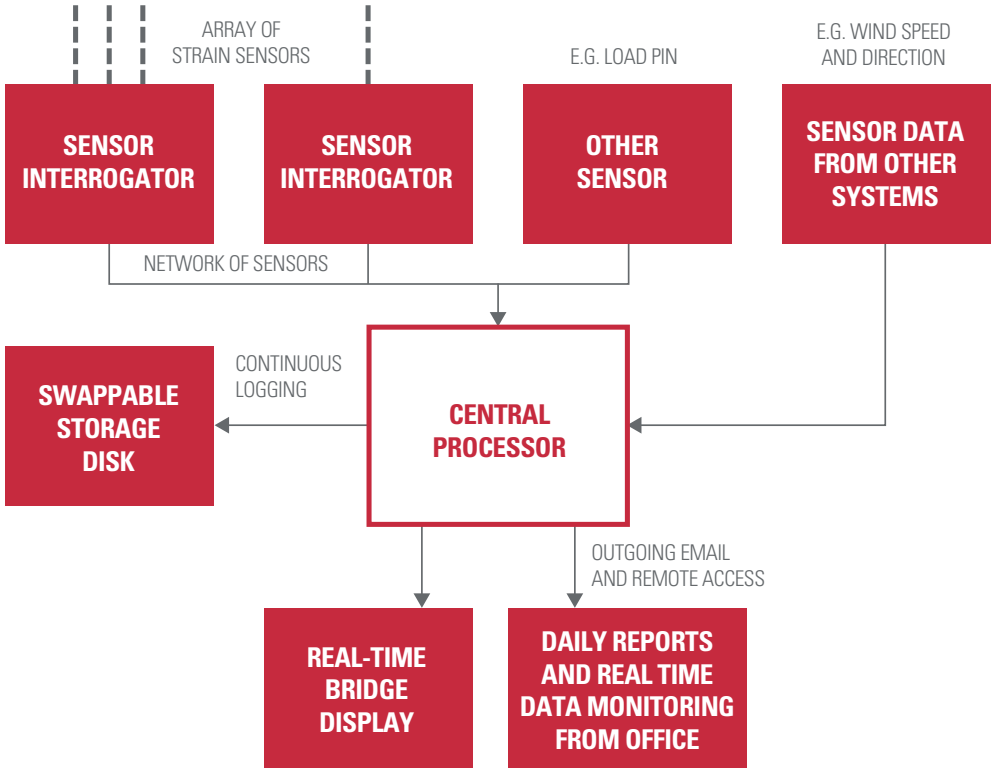
DELIVERING SUPERIOR MEASUREMENT TECHNOLOGY

Fibre optic sensing is a proven, cost-effective technology that offers major advantages over conventional measurement methods. It is widely used throughout many industries and in many demanding applications.

Fibre optic sensing can offer:

- Design validation
- Process optimisation
- Condition Monitoring (CM) and Structural Health Monitoring (SHM) of structures
- Reliable load measurement data
- Improved performance and reliability of materials and design
- Risk reduction in innovative product development and structural designs
- Optimised prototype testing and measurements
- Materials testing
- Warranty validation
- Damage and collision assessment
- Critical data provision for insurance purposes
- Performance enhancement monitoring



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LOAD MONITORING FOR STRUCTURAL PURPOSES

MONITORING OF DESIGN PARAMETERS IN SUPERYACHT SAILING RIGS

The team at Magma Structures were responsible for designing and manufacturing the award winning DynaRig sailing system on the Superyacht Maltese Falcon.

Incorporated into the design and build of the rigs was a unique fibre optic strain monitoring system that monitors the loads on the rigs to ensure that the rigs are not overloaded when sailing and provides a comprehensive load history of the rig.

The fibre optic sensors were embedded into the rigs during manufacture and the system feeds real time loads directly to the operator on the bridge. The data is displayed on one of the four primary sailing control screens and includes driving forces and heeling forces from the individual masts, thus further facilitating the ease of optimising sail set in any specific conditions.

The Magma Structures team have over 8 years of data recorded from the Maltese Falcon monitoring system. The data is invaluable to show that the rigs have not been overloaded and can provide a wealth of information ranging from details of specific incidents to long term data analysis.

STRUCTURAL MONITORING IN VESSEL HULLS

To monitor the stress and movement of large hull structures due to sea conditions. It is also used to validate design parameters and to monitor the condition of the structure throughout its life for maintenance and insurance purposes.

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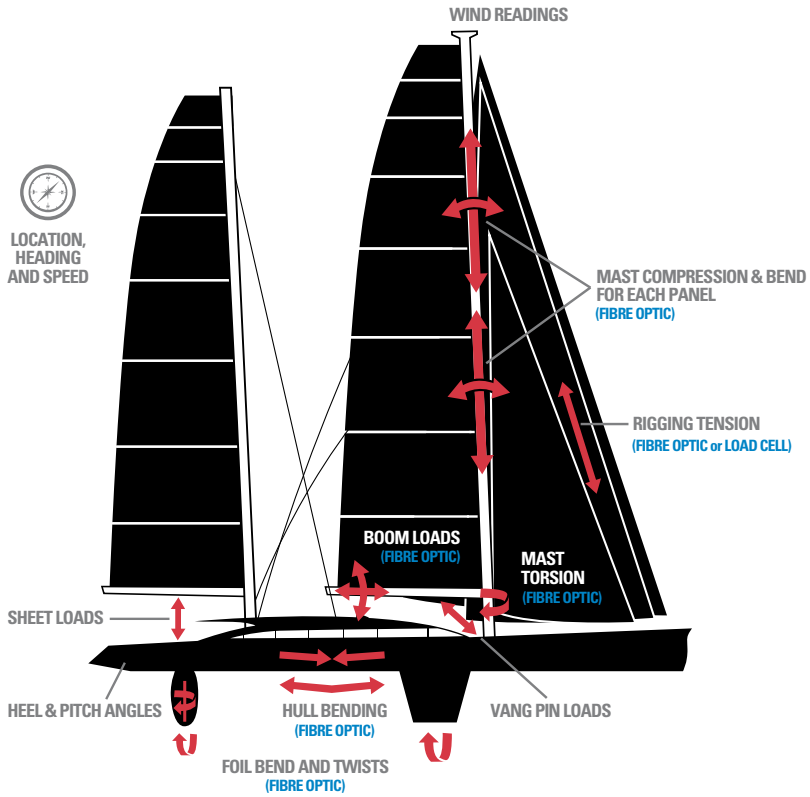
MONITORING FOR PERFORMANCE ENHANCEMENT

OPTIMISATION OF THE DESIGN AND SET UP OF RACING YACHT RIGS

Fibre optic strain monitoring is used to validate the design loads of high tech racing rigs for yachts as well as to improve the performance of the rig during set up, training and competitions. The data is also used to monitor the long-term structural health of the rig mitigating the risk of overload and structural failure during competitions.

The potential applications for the performance enhancement market include:

- Driving force/heeling moment displays enable the crew to finely tune the sail trim based on measured performance and to optimise it for speed or comfort.
- Direct feedback of the mast panel compression and bending shape in both directions when sailing.
- Real time graphical display available to riggers when tuning shroud adjustment and jacking up the mast, and an enduring record of the rig setup and tuning process.
- Loads on the foil can give a visual indicator to the helmsman to indicate when the helm is overloaded and the sails need to be adjusted to reduce helm. The visual indicator to the helmsman restores an artificial 'feel' that is otherwise absent when helming a large yacht.



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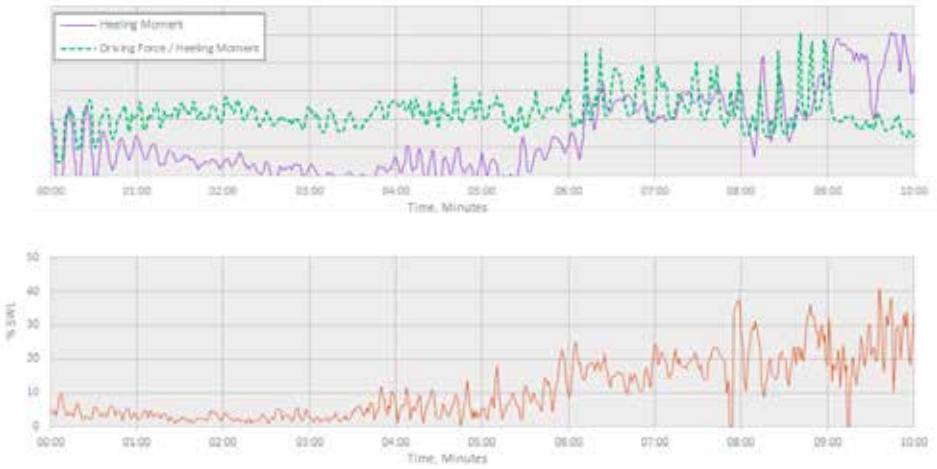
DELIVERING TANGIBLE BENEFITS

Fibre optic monitoring offers significant benefits for the design, manufacture and post-installation operation of large structures.



Specific benefits include:

- Simple to install and set up
- Highly reliable: no de-bonding or sensor fatigue even in harsh environments
- Robust: no sensitive electronic components on the structure itself so can be used in extremely harsh environments and extreme temperatures
- Non-disruptive to laminates: the fibre optic cables are very small and non-intrusive and can be surface mounted onto composites' into composites with no effect on the structural performance of the composite
- Sensors Immune to EMI and lightning
- Multiple fibre optic sensors can be fitted within one fibre in complex configurations
- Can be installed during manufacture or retro-fitted
- Variety of parameters can be measured including pressure, load, acceleration, displacement and shape
- Requires virtually no maintenance or re-calibration
- Flexible: sensor numbers, locations and spacings can be custom designed to suit requirements
- Can be linked into other alarm, monitoring and control systems

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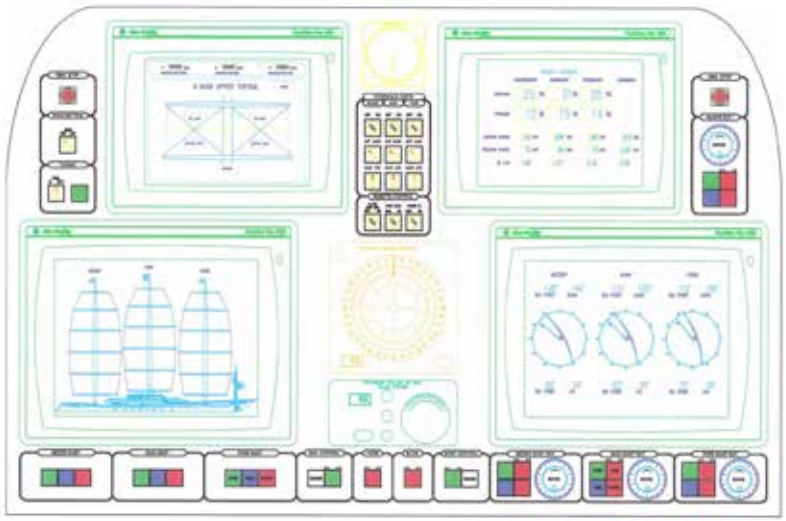
HARNESSING EXTENSIVE EXPERIENCE IN THROUGH-LIFE FIBRE OPTIC STRAIN MONITORING SYSTEMS

The Magma Structures team have unrivalled experience in using fibre optic strain monitoring across a wide range of industries and in a broad spectrum of applications including oil and gas, wind turbine, marine and construction.

The team at Magma Structures offer a bespoke, customer-led service to offer reliable structural monitoring solutions for any application.

Specifically the team offer:

- Design of monitoring system
- Supply of state-of-the-art strain fibre optic strain sensor patches and cabling using industry standard Optical Fibre Bragg Grating sensors (FBG)
- Installation of the monitoring equipment either during build or retrofit
- Supply of an industrial enclosure with processing unit to collate and transmit the data
- Data acquisition using the fibre optic strain sensors which give a highly accurate measurement of physical parameters
- Data analysis using sophisticated tools to provide insight, correlation with design and summarised load history
- Real time calculation of loads and performance data from sensor measurements'
- Real-time display of relevant data in user-friendly format Graphical User Interface (GUI)
- Design of data to be integrated with other alarm, monitoring and control systems.



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KEY CONTACTS

If you would like to talk to Magma Structures about your specific requirements, please contact us for an informal discussion.

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"The free-standing, carbon spars on Maltese Falcon stand 200 ft tall and support nearly the same bending moment as the wings on 767. Each of three carries more sail area than the entire wing on a 747 or A380. The wall thickness at the deck level is over two inches, which exceeds that of the 787 wing, which is the thickest, most highly loaded part of our Dreamliner. There is a display in the wheelhouse on Maltese Falcon based on 96 fiber optic sensors that tell the crew what percent of design load they are at when sailing. This is more advanced than any aerospace application for composite structure."

Boeing Aircraft Corporation
William Roeseler , Technical Fellow Boeing
(Composites and Structural Engineering)
Advisory Board AIAA, MIT

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