CREW FOR A CAUSE — ENGINEER WALKING 1, 386 KM TO RAISE £50,000 FOR CHARITY, page 11

DOCKWALK

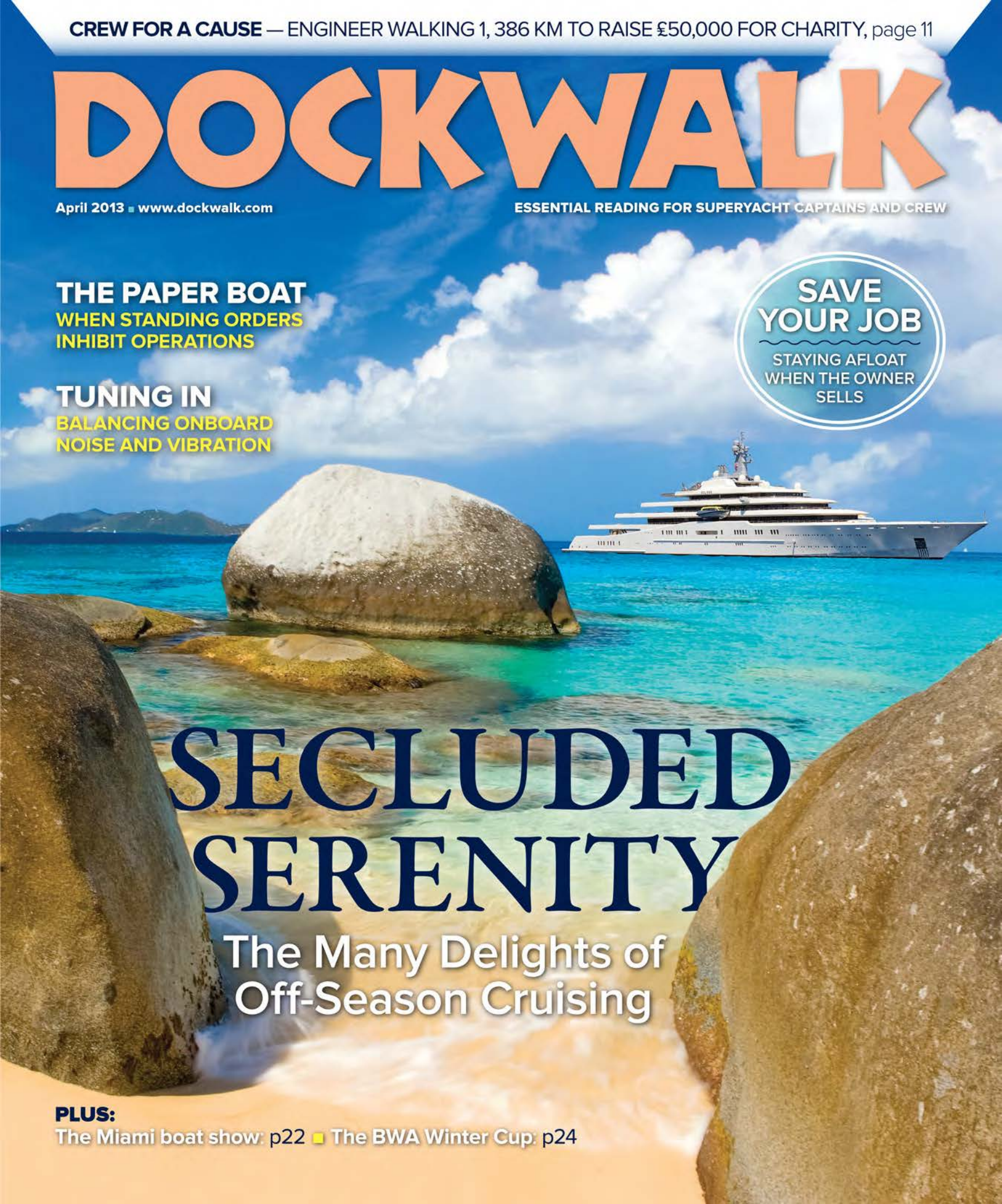
April 2013 ■ www.dockwalk.com

ESSENTIAL READING FOR SUPERYACHT CAPTAINS AND CREW

THE PAPER BOAT
WHEN STANDING ORDERS INHIBIT OPERATIONS

TUNING IN
BALANCING ONBOARD NOISE AND VIBRATION

SAVE YOUR JOB
STAYING AFLOAT WHEN THE OWNER SELLS



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The Many Delights of Off-Season Cruising

PLUS:
The Miami boat show: p22 ■ The BWA Winter Cup: p24

Catch the VIBE

NOISE AND VIBRATION MAY HAVE SERIOUS HEALTH AND OPERATIONAL REPERCUSSIONS ON BOARD, BUT SEVERAL COMPANIES ARE TACKLING THE ISSUE FROM THE INITIAL DESIGN TO FINE-TUNING THE ENGINE.

BY RICHARD BOGGS

FEELING A BIT MORE AGGRESSIVE than usual? Maybe you aren't as excited about taking an active role in safety drills as you used to be — there's a good chance it really is a matter of "bad vibes."

Noise really can drive you crazy; it can also kill you. Dr. Alice H. Suter, a NIOSH (the U.S. National Institute for Occupational Safety and Health) audiologist stated that among the threats created by noise are "high blood pressure, peptic ulcers, cardiovascular deaths, strokes, suicides, degradation of the immune system and impairment of learning. Noise is also associated with an increase in aggression and a decrease in cooperation."

Noise and Vibration Levels

The negative effects of noise at work and at home have been recognized for centuries. Chariots were banned from the streets of ancient Rome because the noise of iron-shod wheels on cobblestones was literally driving residents to distraction. Some medieval European cities banned horses and carriages from the streets at night or covered the cobbles with straw or soil to reduce noise and allow residents a few hours of respite. City noise so disturbed the delegates to the American Constitutional Convention in 1787 that they had the streets for several blocks around Independence Hall covered with soil to muffle the clatter of hooves and wheels.

The concept of noise as a threat to health is ages old, but the acceptance of noise and vibration as a legitimate threat to health is a relatively recent development. As the threat to health and wellbeing has become better understood, the ceiling for acceptable levels of noise and vibration in the workplace has been substantially lowered in the past few years. Noise is unwanted sound. One man's noise may be another man's sonata — Mozart and Eminem are cacophony to someone.

All noise is created by vibrations; not all vibrations create noise, but all noise and vibration has an impact on our minds and bodies as well as the structures and machinery that surround us.



Laser alignment increases accuracy.



Propeller strut alignment test



Testing hull vibration

The impact of noise and what occupational health specialists now refer to as "whole body vibration" or low-frequency vibrations in the range of one to 80Hz is the subject of much current research. Well below the threshold of human hearing, these vibrations are now known to contribute to degradation of human performance as well as contribute to larger health issues. Researchers have shown that these often unrecognized vibrations, when combined with noise, can have effects on cognitive tasks — navigation, situational awareness or recognition of an alarm — that neither of those stressors alone might produce.

The Maritime Labour Convention, 2006 addresses noise and vibration as hazards equivalent to chemical exposure. Aircraft accident investigation reports commonly show the results of how our brain responds to sensory overload. We have a finite ability to process information, and when our connection to the world is saturated with environmental "spam" — noise and vibration — we unconsciously begin to send what may be critical messages to "junk mail," with often tragic results. One hundred-one people died in the crash of an Eastern Airlines flight in the Everglades just northeast of Miami when no one in the cockpit heard an alarm because they were distracted by what turned out to be a burned out light bulb.

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Structural Vibration

Each type of machine produces a characteristic vibration, a "signature" related to its rate of rotation or the number of cylinders or poles that produce fluctuations in the flow of power into or out of the device.

No machine is an island, it either drives or is driven by another machine or combination of machines, so the vibration produced by one may be harmless by itself, but when combined with those of a nearby or connected machine, it may produce an effect far more damaging than any single device. A defective or poorly performing fuel injector may produce a vibration or noise that seems to originate in the reduction gear. Invisible damage to a single propeller blade may cause the compressor in the galley fridge to shake enough to frighten the chef. In the world of nautical noise and vibration, things are seldom what they first appear.

The movement of a machine that is transferred directly to the hull or the device in or on which the source is mounted can present more problems. Solving those problems is a technical challenge. Diagnosing the problem requires an artist with an expanding palette of ingenious tools.

Dutch noise control specialist Intersona BV works with yacht designers and builders to design noise out of the yacht while it's still on the drawing board. Through the powerful Finite Element Method (FEM) or computer analysis programs that mathematically calculate the response of each component of the yacht's structure to vibration, small changes can be made during construction that lead to large reductions in both airborne and structure-borne noise and vibration. Moonen Yachts used Intersona's expertise in the design of the recently launched 42-meter *Sofia* to reduce noise levels to as low as one-tenth of the level required to meet the already very quiet Lloyd's Class 1 noise standard.



Maurizio Paradisi

Master stateroom on M/Y *Darlings Danama*

Noise Cancellation

Awareness of the potential costs of excessive noise and vibration is one thing, doing something to reduce or eliminate it has become an industry in itself. Noise and vibration can be effectively reduced through the use of several techniques: absorption, installing barriers or enclosures, structural damping, isolation and, most recently, a technique used by iPod wearers and airline passengers — active noise cancellation.

Italian yacht builder CRN is working with the Ancona, Italy-based audio-visual integrator Videoworks SPA to develop an active noise cancellation (ANC) system for use in staterooms and other public areas of large yachts. A prototype system installed on the 60-meter CRN *Darlings Danama* reportedly reduced noise levels around the bed in the master stateroom by nearly 50 percent beyond that achieved by conventional sound reduction methods.

ANC works exactly like the now nearly ubiquitous noise-cancelling headphones or ear buds. A tiny microphone samples surrounding sounds that are then processed to produce a sound wave at exactly the same frequency and amplitude, but 180 degrees out of phase — a sort of anti-sound that cancels what we would otherwise hear as noise. As Videoworks' technical manager Maurizio Minossi says about the *Darlings Danama* installation, "We position a microphone close to the pillows on a bedhead; it senses noise and sends it to the audio sensor, which produces an equal and opposite noise. The two sound waves collide and cancel each other." By using the latest in microspeaker technology, the system can easily be hidden from sight. On *Darlings Danama*, the microphones and speakers are disguised as buttons in the headboard.

A recent technique for passive vibration reduction from rotating machinery involves the installation of carefully calculated weights attached like tuning forks to the machine mounts. These weights move at the same frequency and amplitude as the source of the vibration but because they are slightly removed, far enough out of phase, they act just like noise cancelling headphones to stop vibrations before they become noise.

SOUND-ABSORBING MATERIALS CONVERT SOUND ENERGY TO HEAT OR ALTER ITS CHARACTERISTICS SO THAT THE AMPLITUDE OR THE FREQUENCY OF SOUND WAVES IS LESS DISTURBING.

Sound Absorption

Airborne noise can be controlled to a great extent by placing materials that impede the travel of sound waves between the source and crew or guests. Sound-absorbing materials convert sound energy to heat or alter its characteristics so that the amplitude (strength) or the frequency of sound waves is less disturbing.

One creative example on the absorption spectrum is the collection of acoustic curtains from Annette Douglas Textiles Acoustics. The "Silent Space Collection" is light, transparent and flame-retardant acoustic fabrics with excellent sound absorption properties. The Swiss-made fabric absorbs around five times more than common transparent sheer fabrics and can be used as backdrops or window treatments. Three textured weaves are available and a variety of pale, neutral colors should fit most interior décor schemes.

Science at Work

Fort Lauderdale is home to a brace of companies with the ability to combine technical sophistication with an artist's ear and a marine engineer's feel for locating the source of that "funny noise" and correct the problem before it becomes an expensive nightmare.

Chris Brown, president of High Seas Yacht Service (and subsidiary machine shop Straight Line Marine) based at Lauderdale Marine Center, zeroed in on the subject when he wrote in his online blog, "… the skill, knowledge, and expertise truly exist in a technician's ability to interpret the results." On the shelves in



Courtesy of Advanced Mechanical Enterprises

Rich Merhige monitors vibration readings during a sea trial.

Brown's shop are examples of bearings, seals and shafting components that have failed in sometimes spectacular and unexpected fashion. While Brown and his crew use the latest in high-precision alignment tools to reduce or eliminate noise and vibration from drivetrain-related sources, his real strength may lie with an artist's ability to see, hear and interpret the signals within the noise.

Advanced Mechanical Enterprises (AME) owner Rich Merhige and his team combine the latest in technical innovation to collect noise and vibration data, which is then processed with software that incorporates artificial intelligence, the collective knowledge and experience of generations of experts in the field.

AME's analysis of noise and vibration begins with measuring and recording the frequency (how fast) and the amplitude (how much or how far) a machine moves as a result of imbalance or other internal or external forces. Through a combination of signal filtering, signal analysis and artificial intelligence, information can be extracted from — no pun intended — the cloud of background noise that fills an operating yacht. Modern vibration analysis tools literally places the wisdom and experience of thousands of man-years of troubleshooting, maintenance and forensic investigation at an engineer's disposal. When combined with oil sampling, vibration analysis becomes a powerful resource for a yacht engineer to accurately predict future maintenance costs and prioritize equipment replacement or service.

CARRIED TO ITS EXTREME, RESONANCE CAN, AND HAS, CAUSED BRIDGES TO FAIL AND AIRCRAFT TO DISINTEGRATE IN FLIGHT.

AME recently helped solve the cause of excessive vibration on a high-speed catamaran ferry in the Caribbean. The ferry was plagued with a low-frequency vibration that was worse on one side than the other and caused the hull to "drum" at a certain engine rpm. Technicians collected vibration data from the usual suspects — engine mounts, reduction gears, torsional couplings, shaft and propellers and found a strong relationship between the frequency of exhaust pulses at that rpm and the "natural frequency" of the hull itself. All structures will vibrate at a certain frequency when excited by an external force. Designers are careful to place this natural frequency outside the range of vibrations the structure is expected to experience, but occasionally the unexpected occurs and the external source causes the structure to resonate, or produce a stronger vibration with each additional input. Carried to its extreme, resonance can, and has, caused bridges to fail and aircraft to disintegrate in flight.

It appeared that the ferry hull, or part of it at least, was resonating from something related to the exhaust system, but it wasn't until the technicians looked at construction drawings that they noticed a slight difference in the angles that the underwater exhausts exited the hull. This subtle difference was enough to produce a variation in pressure between port and starboard outlets and produce a pulse at exactly the right frequency and amplitude to excite the hull structure. Problem solved. ***DW***