Greensea develops technology to improve the relationship between man and machine, and to make the work they do together more effective, more efficient, and more powerful.

Technology has allowed us to create powerful new machines. But while advances in sensor technology have made marine vehicles more capable, they have created an increasingly complex environment for the operator.

Greensea started in 2006 based on the belief that a reliable, operator-friendly, integrated navigation and control system could dramatically improve the work we do with our marine vehicles. Today, we provide practical commercial solutions to make the hard work of the marine industry easier, cheaper, and ultimately more effective — all from the unlikely, yet lovely, location of Richmond, Vermont.

Thank you for the opportunity to share our story.
A Marine Industry Operating Platform

OPENSEA is a patent-pending operating platform for the marine industry that transforms current technology investments into powerful vehicle solutions. This mature technology is behind all of Greensea’s products, and has over eight years of use in the field, including on some of the world’s most advanced ROVs. Developed by the offshore-experienced Greensea team, this robust technology was purpose-built to make operations easier and more accurate while minimizing expense and risk.

Native support for thousands of sensors – regardless of brand.

98%+ of system code doesn’t change – regardless of vehicle or sensor set.

Built by experienced offshore operators to be simple to use.
Greensea Marine Systems

Greensea’s products are currently running on more than 500 marine vehicles of varying shapes and sizes. Using the OPENSEA software platform, Greensea can provide flexible, scalable navigation and control systems — allowing the same high-quality, reliable products to run on micro-ROVs, large work-class ROVs, submarines, hybrid vehicles, jet-propelled boats, and more. In 2016, Greensea systems will be found throughout the marine industry and around the world.

Greensea can also be found on the STIDD RNAV2 and AP2 diver propulsion devices. With Greensea’s high-accuracy navigation and control system surveillance, detection, identification, and prosecution of targets can be executed efficiently and repeatedly.
Tightly integrated navigation and control technologies make vehicles more capable by sharing critical data throughout the system. Centralized data increases awareness for both the vehicle and the operator. This awareness, supported by an easy-to-use interface (we call it Workspace), can dramatically improve productivity.

All Greensea navigation and control systems are integrated using the OPENSEA software platform. OPENSEA unifies Greensea products with sensor technologies from other manufacturers to provide one integrated system for your vehicle.
Balefire is an easy-to-use, advanced vehicle control system for the marine industry. It provides exceptional vehicle stability and maneuverability, allowing operators to focus on their mission rather than the vehicle. Using the OPENSEA platform, Balefire provides a stable, robust operating environment while still offering customization. The basic Balefire system can be easily upgraded by adding modules that are installed by simply downloading an update on your topside computer. Balefire comes with a fully integrated Workspace (user interface) to provide the operator with a complete, in-depth view of their system.

As with all Greensea products, Balefire is delivered as an easy-to-install hardware/software product. Depending on your vehicle, it can be integrated topside or subsea.

**Balefire Basic Control**

- Auto depth
- Auto altitude
- Auto heading
- Fly-by-wire
- Cruise Control
Mission View
- Mission Planning
- Waypoints
- Georeferenced Charts
- Markers
- Man Overboards
- Heads-Up Display
- Measuring Tools
*Geographically Overlaid Sonar

Sonar View
- Target Tracking
- Networkable
- Export to Standard Video Files
- Multi-Sonar Support
- Logged & Synchronized
- Georeferenced within Workspace
- Intuitive Controls

Video View
- Configurable Video Overlay
- Networkable
- Export to Standard Video Files
- Multi-Video Support
- Logging, Archival, Playback

Vehicle Positioning
- Station Keeping
- Dynamic Positioning
- Reacquisition
- GOTO Position
- Advanced Fly-by-Wire
- Autopilots: Depth, Altitude,
  Heading, Pitch, Roll, Velocity,
  Descent/Ascent

Automated Positioning
- Mission Execution
- Waypoint Execution
- Task Automation
- Real-Time Supervision

Sonar Positioning
- Target-Relative Positioning
- Target-Relative Control
- Click-to-Acquire
- Hazard/Keep Out Zones

All advanced vehicle positioning modules require vehicle position data provided by an INS plus one or more aiding sensors (e.g. Doppler Velocity Log, LBL, USBL, line counter, etc.).

* When paired with the sonar view module.
The Balefire Workspace fuses vehicle control, navigation, sensors, diagnostics, and data management into a single screen. For many operators, this means the elimination of screens, computers, and third-party navigation packages. The centralized data framework allows visualization, logging, archival, and playback of all vehicle and payload data, including sonar and video with extension modules. With this powerful work environment, you’ll see a dramatic improvement in the data quality you can mine from every mission.
Greensea’s Balefire Workspace is a fully distributed, networked system supporting multiple users, even in different locations. Team members can share vehicle and target data in real-time between local workstations and a field office or remote command stations. Operators can also configure the screen based on their task – drag edges of a window to enlarge or hide areas on the screen.

DATA LOGGING
- Comprehensive data logging and archival
- Data playback
- Log marker utility
- Raw sensor logging
- Sonar and video recording with nav sync

CHART PLOTTING
- Third-party navigation package replacement
- Integrated ship navigation
- Chart / Geodata / Bathy support
- MOBs, waypoints, routes, & marker support

MISSION PLANNING
- Mission archival and recall
- Real-time mission modifications
- Target management
- Hazard zone support

NETWORKED
- Multi-operator support
- Local and wide area integration
- Streaming sonar and video data

DIAGNOSTICS
- Individual device diagnostics
- Aggregated health and status
- Real-time signal visualization

ALARM MANAGEMENT
- User defined alarms
- Logged alarms
- Target management
- Hazard zone support

NETWORKED DATA DISTRIBUTION
- Distributed via Balefire Hub
- Support of unlimited individual workspaces

Greensea’s technology makes operating a vehicle easy. Marybeth Gilliam, Greensea’s CMO, VP Sales is flying solo after a brief lesson in autopilots. The Deep Ocean vehicle she is flying uses the INSpect GS inertial navigation software and a full Balefire system.
The INSpect GS inertial navigation systems (INS) deliver low-cost, accurate navigation with substantially less size, weight, and power requirements than traditional INS products. Using the OPENSEA software engine, the INSpect GS products fuse and filter data from available navigation aiding sensors to produce an accurate and stable navigation estimate that minimizes noise, bias, and variable sensor data rates. Vehicles receive optimized data for position, velocity, heading, altitude, depth, pitch, and roll to support advanced vehicle control.

INSpect GS1 software supports most sensor configurations and is delivered in an OEM format.

INSpect GS4 FOG INS is an easy-to-install, fully-integrated system that can accommodate a wide array of aiding sensors and be upgraded to include Balefire vehicle control.

Increase the accuracy of the INSpect INS with a high-accuracy depth sensor and a fully integrated Doppler Velocity Log (DVL).
Optimized For Vehicle Control

Greensea’s INSpect GS inertial navigation systems are built on a flexible and scalable software/hardware architecture that’s optimized for vehicle control. Add mission planning, autopilots, and even full automation to the basic INS and all the navigation and control capabilities — 2D chart plotting, data logging, diagnostics, and user tools for operating and configuration — are integrated and pulled together into the Balefire Workspace.

**Features and highlights for the INSpect GS product line:**

- Sensor fusion
- Full INS positioning
- Small, integrated high-accuracy fiber-optic gyro (FOG)
- Integrated high-accuracy depth sensor
- Integrated magnetic digital compass
- Use existing navigation aiding sensors: USBL, LBL, DVL, GPS, odometer, altimeter, turns counter, and other orientation sensors
- Easy to install
- Small and lightweight
- Works with any vehicle or sensor set
- Uses patent-pending OPENSEA technology
- Proven for mid-water station keeping
- Optimized for advanced vehicle control

**Colin Riggs**

Sr. Robotics Engineer  
Product Development  
Physics & Math Degrees  
Organic Farmer

**Shay Osler**

Robotics Engineer  
Electrical Engineer  
Sonar Specialist  
Diver, Subsea & Sky
Greensea offers standard vehicle support packages for most of the industry’s ROVs. Depending on the vehicle, the Greensea system can be installed as either a small subsea bottle, a topside box, or an integrated OEM solution. No matter how it’s integrated, the Greensea system will be easy to install, easy to use, and easy to maintain. The full suite of Greensea products is available for any vehicle.

The Deep Ocean Phantom integrates Greensea’s system with a small subsea bottle that mounts neatly to the skid. Legacy vehicles can be supported.

The Sub-Atlantic Mojave uses a topside box for their Greensea system. The box connects directly to the Mojave surface control unit.

Greensea’s proprietary Falcon technology allows the Greensea system to be easily integrated inside the existing Falcon topside box — without any additional external hardware. External solutions are available if preferred.

The SeaBotix vLBV integrates Greensea’s system with a small subsea bottle that mounts neatly on the skid or on top of the foam pack when using our mounting bracket.
Custom Greensea Systems

Greensea systems can be found on some of the world’s most advanced ROVs. These powerful work-class systems are equipped with an extensive suite of instruments, cameras, and sensors. The full payload — from the main camera pan-and-tilt to tooling skid — is supported by Greensea’s technology. Although these systems are extensive, 98% of Greensea’s OPENSEA software doesn’t change regardless of vehicle or sensor set.

Monterey Bay Aquarium Research Institute
Ventana, 1850 meters

National Oceanic & Atmospheric Administration
Deep Discoverer, 6,000 meters

Canadian Scientific Submersible Facility
ROPOS, 5000 meters

Easy-to-use
In 2014, MBARI partnered with Greensea to conduct a major upgrade for their aging ROV. Greensea was selected to provide an integrated system-wide solution that would make operations significantly easier.

Proven
NOAA selected a Greensea system for their 6000m ROV, Deep Discoverer, in 2013. The system has reliably supported hundreds of dives and has proven to be valuable scientific asset.

Reliable
In its first voyage using their Greensea system, ROPOS achieved 98.9% availability. In 34 operational days, ROPOS accumulated over 134.5 hours unused maintenance time while spending 248 hours submerged on more than 50 dives.

“To do it with the waypoint tracking that’s integrated into the Greensea system is pretty simple... You just enter your end points and your start points and away you go, as opposed to having someone write a whole bunch of control code and integrate the DVL. It was a big effort every time we did it, so having it integrated is a big deal for us.” — Craig Dawe, MBARI’s Technical Support Manager and Ventana’s Chief Pilot

Heath Hescock
Robotics Engineer
Electrical Engineer
Prototypes & Designs
Outdoorsman & Skier
Greensea stands behind all their products. Every Greensea system comes with one year of Basic service which includes online support, bug fixes, five hours of online training with one of our engineers, access to the Greensea Knowledge Base, and more. Upgrade to Professional or Enterprise service plans and receive additional support and training from Greensea engineers.
Team Greensea

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