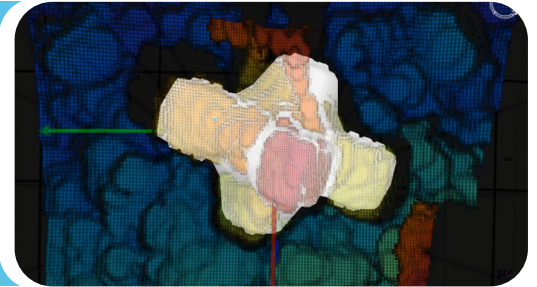
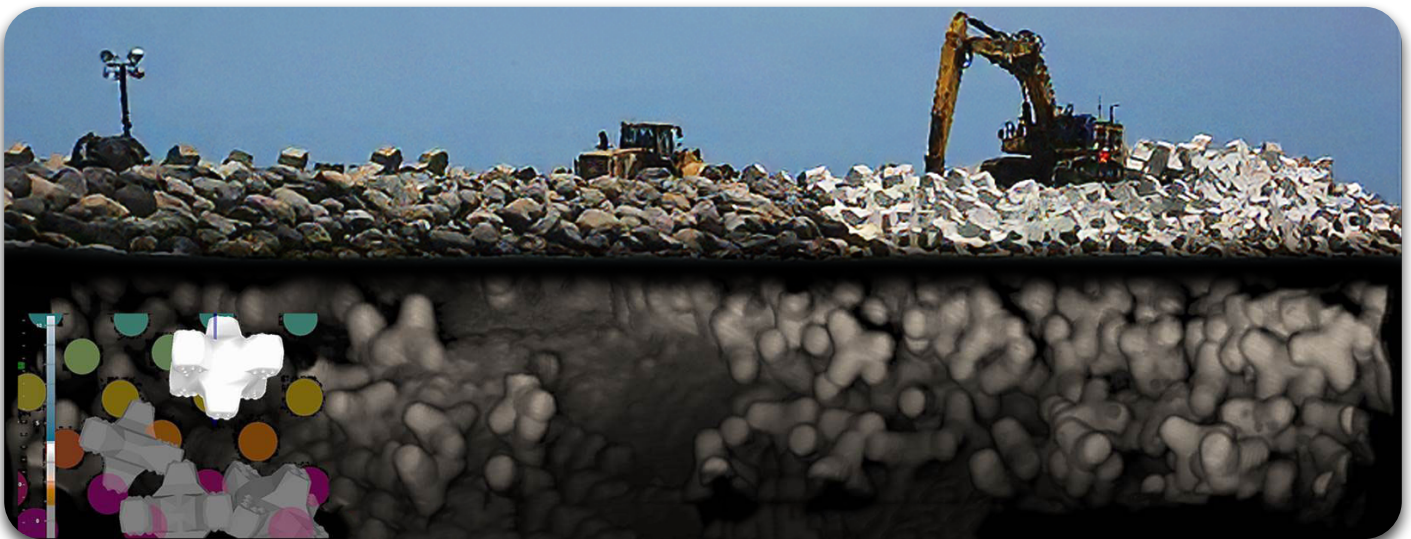


Construction Monitoring Solution (CMS)
A Patented Solution



CMS is a full life-cycle Construction Management System for breakwater projects, CMS supports everything from design through construction, maintenance, and inspection. Using patented real-time 3D technology, it enables teams to see, track, place, monitor, and validate block installation while capturing settlement movement. The platform delivers a high-fidelity digital twin, providing engineers with accurate, actionable data throughout the project lifecycle.

A Patented and Complete Breakwater Construction Management System to See, Track, Place, Monitor, Validate and Document Concrete Armored Block Placement



Version 04.26

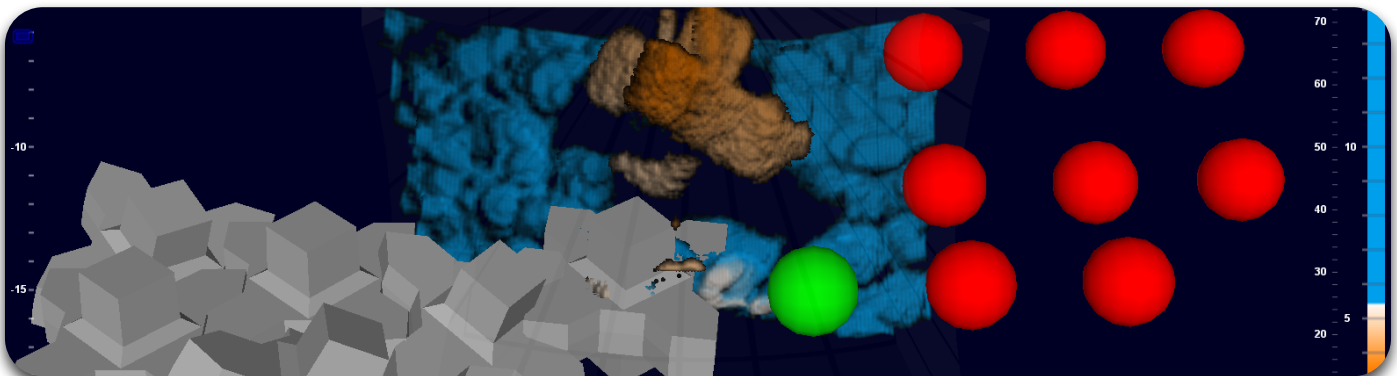
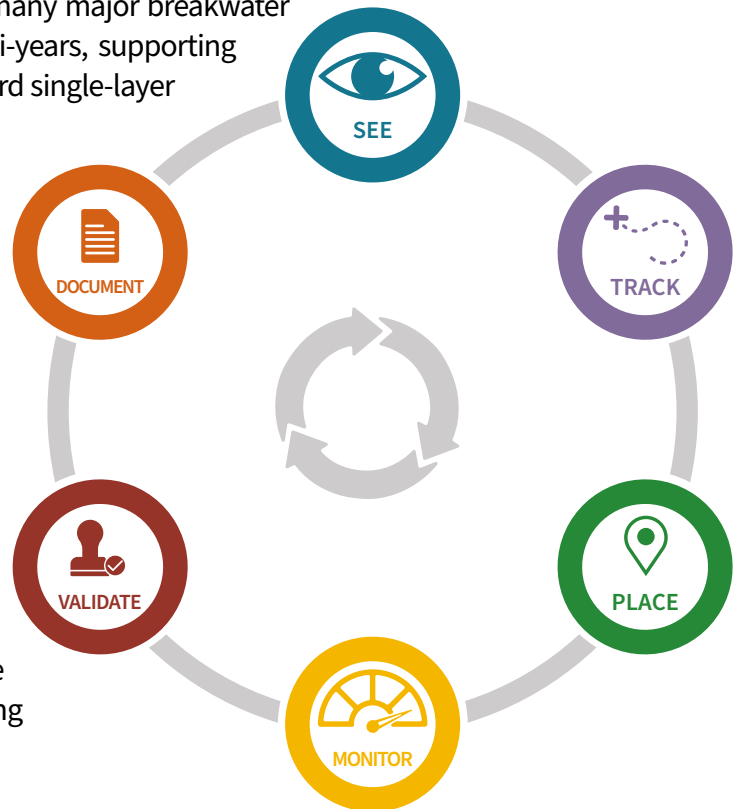
Construction Monitoring Solution (CMS) History

CMS is the leading, industry-proven solution, developed in collaboration with prominent marine engineering firms since 2008. It is formally approved by armour unit manufacturers who define breakwater design specifications. CMS is used on many major breakwater projects worldwide, many of which run over multi-years, supporting both the pre-and post-lay surveys across all standard single-layer concrete armour block types.

The CMS solution integrates with our Echoscope PIPE® real-time 3D sonar systems and our latest Echoscope® AIR LiDAR 2.0 real-time 3D sensor to deliver seamless, real-time visualization above and below water. This enables continuous tracking of moving blocks at all stages of construction, in all water conditions and day or night visibility.

In addition to the critical real-time visualization for crane operators, the system can provide precise measurement of block position and orientation, and supports accurate placement, and records verified as-laid data, delivering survey-grade results in full compliance with project engineering requirements.

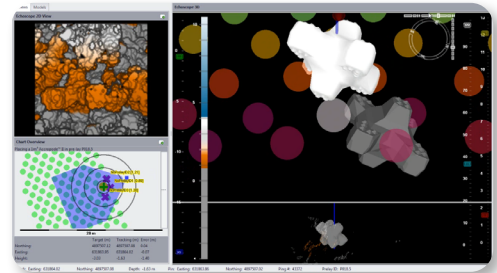
Unlike traditional breakwater construction approaches, which often require separate technologies for placement, slope and placement survey, CMS enables the entire workflow steps to be performed on demand, using the same equipment, eliminating the need for survey vessels or additional sensors.



Because the solution provides a seamless and dynamic work-flow and allows the operator to see the blocks in real time 3D, this significantly reduces the time it takes to place the blocks and increases the safety of those involved in the block placement process. Users of our CMS Solution obtain significant productivity gains, increasing the number of blocks placed to anywhere between 76-200 blocks per day, while at the same time increasing safety.



Our patented Block Tracking technology creates significant benefit throughout multiple stages in the breakwater construction process. Block Tracking can be employed for the live placement of the blocks, Block Detection post-lay as the panel is built, capturing settlement of the block and finally Block Detection of the entire panel and breakwater from final as-laid survey data.



See, track, place, record and document blocks as laid

The acoustic point cloud data of each block is recognized by the software, a 3D model of the block selected by the operator and the solution automatically locks the model onto the point cloud data. The operator has a clear 3D model of the block to work from, enabling increased accuracy of block lay, as the operator can 'see' all sides of the block



Real-Time Visualization

Real-time 3D visualization of blocks and slope irrespective of water conditions for increased productivity, diver-less placement and pre/post-lay survey



3D Automatic Tracking

The unique model tracking technology means the final position and attitude can be recorded in the global CMS database. The tracking can be further activated on subsequent survey data allowing the master asset database to be quickly updated with any block-placement movement



Construction Workflow Management

CMS provides the capability to manage, monitor and document the entire construction phase of asset placement projects. Site design, prelay information, and data can be loaded into CMS (full X,Y,Z positions and rotations) for control, progress reporting and full-time visualization of placed assets, including those being actively placed

CMS generates industry standard deliverables for breakwaters and extends to the full scope breakwater construction from:



- VISUALIZATION OF BLOCK**
- ACCURATE BLOCK POSITION**
- MAINTAIN MINIMUM SEPARATION BETWEEN BLOCKS**
- MAINTAIN MINIMUM PACKING DENSITY OF BLOCKS**
- QUALITY CONTROL OF EACH BLOCK POST-LAY POSITION**



- 3D MAP OF COMPLETE BREAKWATER**
- XYZ POSITION OF EACH BLOCK**
- PRE- AND POST-LAY SURVEYS**
- DETECT BLOCKS MOVED FROM POSITION**
- QUALITY CONTROL OF EACH PANEL/ COMPLETE CONSTRUCTION**

Using CMS enables precise tracking and recording of block position and orientation throughout placement, post-lay analysis, and final survey data collection—without the need for additional sensors.

The system provides real-time 3D underwater scene awareness for crane operators, supporting continuous 24/7 operations regardless of water visibility. This improves placement accuracy, increases productivity, and enhances confidence in the final resting position of each block.











By improving operational visibility, CMS also enhances diver safety and reduces reliance on divers during installation. In addition, it supports real-time, survey-grade slope inspection before, during, and after placement, as well as full post-lay surveys of completed panels—all using the same equipment.

The platform is adaptable for both wire cranes and excavators, enabling flexible deployment across a wide range of project configurations.

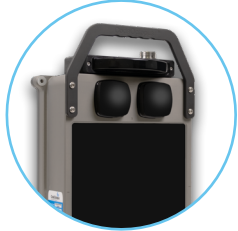


	VISUALIZATION ONLY	VISUALIZATION & MAPPING SOLUTION
BLOCK IMAGING - ASSIST IN PLACING BLOCKS	✓	✓
RELATIVE MEASUREMENTS	✓	✓
ASSESS INTERLOCKING OF BLOCKS	✓	✓
QUALITY CHECK SLOPE PRIOR TO BLOCK LAY	✓	✓
PLANNED BLOCK POSITIONS	✗	✓
REAL-TIME BLOCK TRACKING	✗	✓
3D MODELS OF BLOCKS	✗	✓
DATABASE OF LAID BLOCKS	✗	✓
POST-LAY POSITIONING	✗	✓

CMS supports a number of different block types which are listed below. If your Block Type is not currently listed, please contact us and we can extend our support for your Project Block Type.

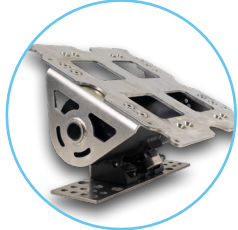
 ACCROPODE™ I	 ACCROPODE™ II
 ACCROBERM™ I	 ACCROBERM™ II
 CORE-LOC™	 Dolos
 ECOPEDE™	 Tetrapods
 XBloc®	 XBloc® Plus

Equipment Composition (With Positioning & Attitude Data)



1. Echoscope PIPE® Surface (With In-Built Wet Switch)

The Echoscope PIPE® Surface Models is supplied with an in-built wet switch, and benefit from being much lighter, while maintaining the same High-Resolution 3D Volumetric capabilities offered by the Echoscope PIPE®. Surface variants are rated at 40m water depth, making them ideal for shallow water applications with good water conditions, such as concrete armored block placement.



2. Integrated Single Axis Rotator (4G ISAR)

The 4G ISAR is a high-performance unit designed to meet the demanding requirements of accurate orientation and position control for real-time 3D Coda Octopus sonar products. All angular and positional offsets are dynamically calculated within the software, ensuring accurate, efficient, and simple operation.



3. F280® Pre-Calibrated Assembly

The F280® GNSS-aided (inertial) attitude and positioning systems are high quality, robust packages for the marine hydrographic and laser survey market. Defined to meet the exacting requirements of the multibeam survey market, the F280 Series® systems are easy to install, easy to use and produce very accurate positioning, heading and MOTION data in the most dynamic offshore conditions.



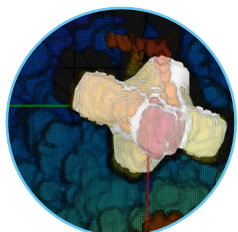
4. Echoscope® AIR LiDAR 2.0

Capable of providing the same real-time 3D volumetric data as the Echoscope PIPE® Series but above the waterline, the Echoscope® AIR LiDAR 2.0 is designed for both mapping and inspection applications, providing seamless above and below water visualization of blocks.



5. 3D Connect 5G & Laptop

Designed to effortlessly handle data and control of all Coda Octopus 3D Hardware while also supporting additional sensors such as Sound Velocity Profilers. The 3D Connect 5G allows users to further simplify deployment of the Echoscope® range of 3D sonars, increasing project efficiency by saving time with an intuitive, easy-to-use solution.



6. Construction Monitoring Solution (CMS)

Our CMS solution is the leading industry solution, which has been developed in collaboration with prominent engineering firms since 2008 and is approved by the Block Manufacturers who design the breakwater technical specifications.



7. 4G USE®

For use with the Echoscope® range of real-time 3D sonars and our Echoscope® AIR LiDAR 2.0, the Coda Octopus' 4G USE® software will enable you to view the scene above and below the water in the highest definition possible, and has been developed specifically to provide significant productivity and result processing capability.

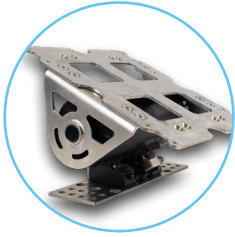
Equipment Composition (Alternative) Visualization Only

Alternatively Operators can utilize the Echoscope PIPE® for Visualization only, allowing for Block Imaging to assist in Placement of Blocks, Relative Measurements for Precise Placement, Access to Interlocking of Blocks and the Ability to Quality Check the Slope prior to block placement. However without Positioning and Attitude Data, Operators lose access to defining traits of CMS, such as Real-Time Block Tracking, Planned Block Placements and a Database of Laid Blocks.



1. Echoscope PIPE® Surface

The Echoscope PIPE® Surface Models is supplied with an in-built wet switch, and benefit from being much lighter, while maintaining the same High-Resolution 3D Volumetric capabilities offered by the Echoscope PIPE®. Surface variants are rated at 40m water depth, making them ideal for shallow water applications with good water conditions, such as concrete armored block placement.



2. Integrated Single Axis Rotator (4G ISAR)

The 4G ISAR is a high-performance unit designed to meet the demanding requirements of accurate orientation and position control for real-time 3D Coda Octopus sonar products. All angular and positional offsets are dynamically calculated within the software, ensuring accurate, efficient, and simple operation.



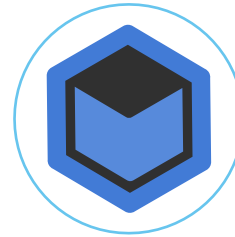
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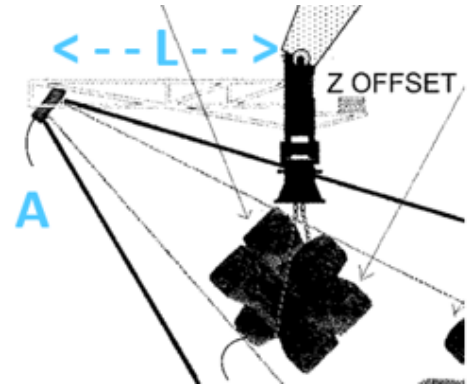
5. 4G USE®

For use with the Echoscope® range of real-time 3D sonars and our Echoscope AIR LiDAR 2.0, the Coda Octopus' 4G USE® software will enable you to view the scene above and below the water in the highest definition possible, and has been developed specifically to provide significant productivity and result processing capability.

Mounting Options

When placing blocks from sea-side, the Echoscope PIPE® can easily be deployed on a barge with a pole-arrangement. The system can be easily deployed on excavator, wire cranes, or mounted on a custom-made frame. The mounting arrangement would be designed by the customer. Coda Octopus will provide assistance through the process, to ensure that the arrangement is suitable to obtain the clearest image of the blocks being placed.

Note: When placing different block sizes, the pitch angle (A) of the Echoscope and the length of the frame (L) are important.



Common Deployment Methods



EXCAVATOR CRANE DEPLOYMENT
This is one of the most common methods of deployment for the CMS solution. The Echoscope® is mounted on a horizontal frame on the placement tool.



SEPARATE FRAME
The Echoscope PIPE® is mounted on a separate frame which is suspended from a separate smaller crane. In this case, the block crane is completely independent of the survey frame. The waterproof IMU and the GPS antenna are mounted on the separate frame used to visualize the block crane.



WIRE FRAME
This deployment is our innovative solution for customers using a wire crane to place blocks. The Echoscope® is mounted on the bottom frame in a similar position to the excavator crane deployment. Then, an 8m pole is connected to the bottom frame to attach a rigid support bar which holds the waterproof GPS and INS mounted on a spreader bar.

Project Successes

Our breakwater solution has been adopted by major operators and is proven to deliver significant productivity gains. Some examples of which are:

ACCROPODE™ Projects	XBloc®	CORE-LOC®
Satah al-Razboot, UAE	Sumburgh, Scotland	Al-Zour, Kuwait
ZADCO Upper Zakum Oil Fields, UAE	Swinoujscie, Poland	Tetrapod
Constanta, Romania	Offshore Islands, Abu Dhabi	Tokushima, Japan
Ras Laffen, Qatar	Dunkerque, France	Bloque Cubic Rainure (BCR)
Moin, Costa Rica	Das Islands, Abu Dhabi	Port of Safi, Morocco
Chara, India	Istanbul, Turkey	Antifer
Tema, Ghana		Hamifratz Port, Israel

Customer Testimonial

Eric Peeters of Van Oord says:

“Van Oord has been using the Echoscope real-time 3D imaging sonar on various projects from 2008 onwards where single-layer artificial armour units (ACCROPODE™ & ACCROPODE™ II) need to be placed. During placement, the Echoscope 3D imaging sonar provides real-time guidance to the crane operator. The Echoscope has contributed to an increased productivity whilst improving safety. Over the last year, Van Oord has taken part in the development of the CMS 2.0 solution which provides, amongst other new features, enhanced ACCROPODE™ tracking functionality which makes it another leap forward to diver-less placement. By providing a test location in Constanta, Romania, it was possible to feed the software developers instantly with new information. Van Oord operates around the world as a leading contractor for dredging, marine engineering, and offshore energy projects (oil & gas and offshore wind).



Construction Monitoring Solution (CMS) System Requirements

Our CMS software is available to license for fixed periods of 6, 12, 24, or 36 months. Each CMS license is linked to a specific Echoscope® sonar and can only be used with this system. Please contact sales@codaoctopus.com for more information on how to obtain a CMS license.

	Recommended
Processor	Intel® Core™ i7/i9 or AMD Ryzen 7/9 Recommended
RAM (Computer Memory)	Minimum 16 GB Recommended
Disk Space (Software)	100mb for installation Approximately 3 - 3.5 GB per hour, dependant on ping rate
Disk Space (Data Storage)	500GB Minimum - 1TB Recommended Data Storage rate is typically up to 3.5 GB per hour (Dependent on ping rate, UIS Camera and Charts and Model Data loaded)
Graphics (Laptop/Desktop)	NVidia® GeForce RTX 4060 (Desktop) NVidia® RTX 4070 (Laptop) <i>*AMD Radeon™ GPUs are not supported</i>
Operating System	Windows® 11
Ethernet (Live Operations)	1 x 10/100/1000 Port (Recommended) 2 x 10/100/1000 Port (Recommended)
USB 2.0/3.0 Ports	3 Minimum 6 Recommended

CodaOctopus® CMS Solution benefits from several key patents

US9,019,795	Method of Object Tracking Using Sonar Images
US10,088,566	Object Tracking Using Sonar Images
US8,854,920	Volume Rendering Sonar
US7,898,902	Method Representation of Sonar Images

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