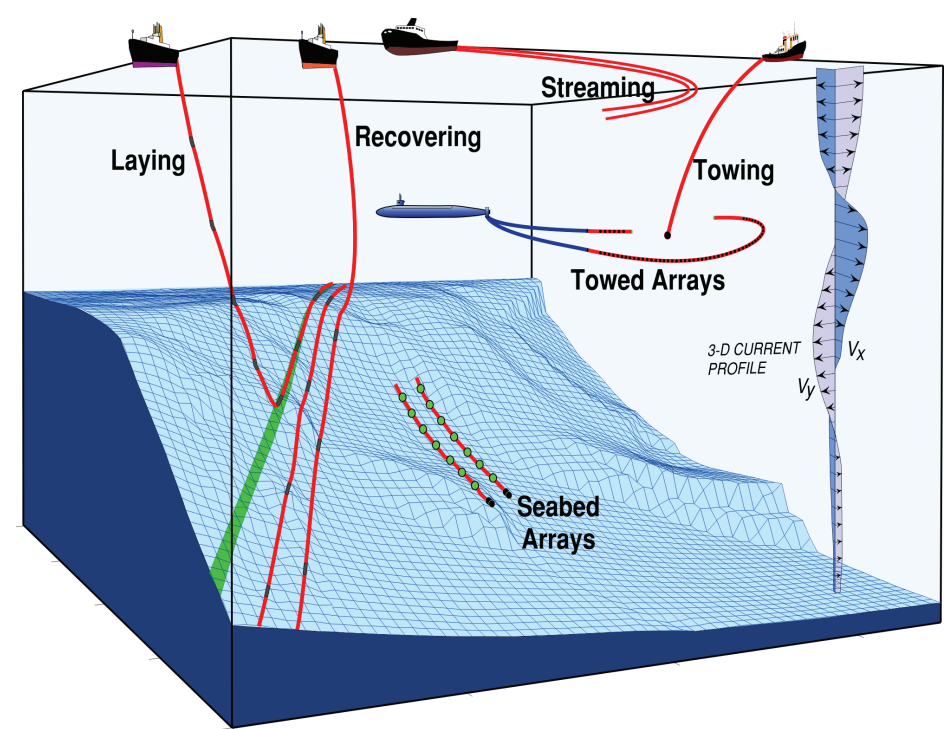


# Marine Cable Services

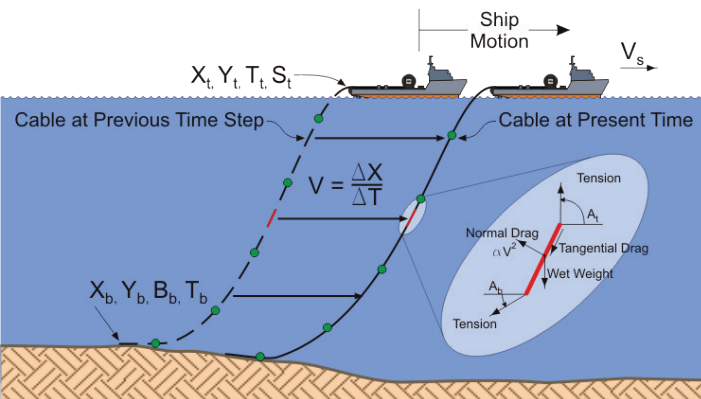
## Submarine Cable Engineering



Are you:

- **Laying**
- **Retrieving**
- **Towing**
- **Dragging**
- **Streaming**
- **Lowering**
- **Positioning**

**Submarine Cables or Arrays?**



Dynamic 3D cable model used by the control system.

### Makai Can Provide Answers

- Is your cable plan feasible?
- Can you control cable tension?
- What are the risks?
- What accuracy is possible?
- Is my equipment adequate?
- What do I need to monitor?
- What are the costs versus performance?
- How do I achieve successful results?

Makai Ocean Engineering, Inc has been providing answers to these questions for over two decades. We are the leading provider of submarine cable planning, simulation and installation software. Let our experienced team of engineers work with you to solve your submarine cable problems.

## MAKAI SERVICES

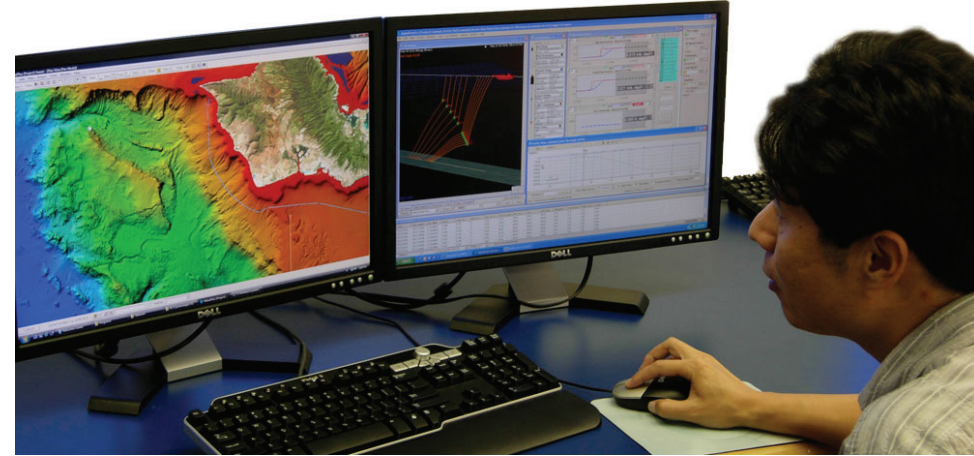
Makai provides a complete suite of cable-related services that use both the expertise of Makai engineers and our software products. Our engineering and theoretical knowledge is well supplemented by over 3000 days of at-sea experience. We can provide a number of references from past clients who have used our products and services for a wide range of cable activities. These activities include:

- Real-time and future predictive hydrodynamic modeling for laying and retrieving seismic, power, communication cables, and arrays in the ocean.
- Hydrodynamic modeling of cable installations, towed arrays, drag arrays, tow fish, and anchor deployment.
- Preliminary design and cost estimates for most cable-related activities.
- Project management.
- Feasibility studies and error budget analyses for at-sea cable operations using our planning and simulation software.
- Specifying handling systems, deck layout, peripheral equipment, and operational procedures.
- Research and development programs for our commercial and military-based clients.
- Providing software, hardware, and personnel for the control of at-sea cable operations.
- Lease or sale of our software products: MakaiPlan, MakaiPlan Pro and MakaiLay.

## IMPORTANCE OF CABLE DYNAMICS

Whether you are setting an anchor, laying a cable, or controlling a streamer, having knowledge of the physical shape of the cable in the water column and how that shape changes over time is extremely important to properly complete your task. Your success may be measured by accurately controlling touchdown placement, by limiting bottom slack or tension, by properly positioning a free cable end, by placing accurately one or more cable elements on the seafloor, or by controlling an array shape. Whatever the task, knowing what happens with your cable in the water column is vital to your success. Makai's engineers and proprietary modeling solutions can provide this complex and often elusive knowledge.

The physical factors affecting cable shape are ocean currents, bathymetry, ship movement, cable payout, cable properties, and in-line components on the cable. Because these variables can change with time, cable shapes are rarely static. A complete knowledge of cable behavior involves not only knowing what your cable is doing in the present time, but also what it has been doing in the past and what it will be doing in the future. Without a full understanding of this dynamic behavior of the cable, at-sea cable operations are often badly planned and executed - leading to cables and arrays that are improperly positioned or damaged.



Engineer simulating a cable installation in the lab.

## CABLE MODELING

While working on numerous submarine cable activities over the years, Makai has developed sophisticated software for simulating a cable installation in the lab and controlling a cable installation, in real time, at-sea. Makai's software includes a very fast 3-D dynamic cable model. This non-linear, time-domain model can accurately compute the shape and dynamic behavior of nearly any cable under nearly any conditions. Modeled cables can have free hanging ends, be laid on the seabed under tension or slack, or even dragged during installation or retrieval. Since it is a rigorous and complete engineering model of cable behavior, it is extremely useful for the analysis, prediction, design and at-sea control of marine cables.

Makai computes cable shapes based on the rigorous dynamics of the cable lay. We know the ship position, the cable paid out, the physical properties of the cable and attachments, the current profiles from an Acoustic Doppler Current Profiler, the 3D bathymetry of the seafloor, and the past history of

the cable. These parameters are adequate to define a unique cable solution. Direct measurement of cable position with acoustics can be included in the model but these positions are not necessary for determining a unique solution.

Makai's model has been highly calibrated and validated in over 22 years of at-sea use.

## CABLE OPERATION FEASIBILITY

Using MakaiPlan Pro, an engineer can fully and accurately simulate a cable operation to determine whether it's feasible, what factors are limiting the operation, whether the operation is controllable, and what problems may develop at each step of the process.

Simulations can be run while including typical at-sea instrument and operator errors, such as differences between the actual currents and the measured currents, or differences between the instructed ship position, the measured ship position and the actual ship position. By including realistic and maximum operational errors, an engineer can perform an error budget analysis and determine what factors are limiting his operation, how well each variable must be measured to achieve certain goals, whether existing equipment is adequate to perform the cable operation, and the costs and time required to assure success.

Another important aspect of the simulation is the evaluation of the controllability of the operation. The computer simulation realistically reproduces actual at-sea conditions. If the cable is not controllable in the simulation, it will not be controllable at-sea. Mistakes are made before they are costly - and corrections are made before you commit to going to sea.

## CABLE CONTROL

Makai uses mathematical modeling of the cable to both monitor and forecast cable motions and to determine optimal actions aboard the controlling vessel. These functions are included within our at-sea software MakaiLay - a fully developed control system for controlling the placement of a cable in water (see Makai's MakaiLay brochure for more details).

## BENEFITS

Makai's products and services can provide safer, faster and less expensive alternatives to more traditional methods of planning, deploying, installing, towing or retrieving submarine cables. Makai's software and services are proven and mature with over two decades of experience.

Makai Ocean Engineering, Inc is located on Oahu, Hawaii, USA. We support cable ship operations and cable planning worldwide.

For more information and pricing contact:

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Makai Pier

