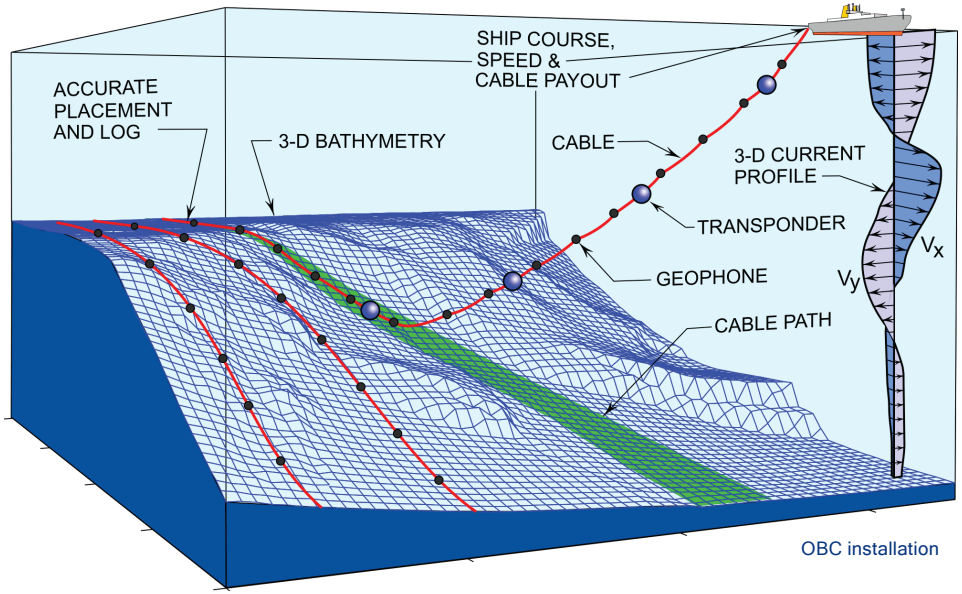
MakaiPlan Pro Seismic

Installation Planning & Simulation Software for Ocean Bottom Cables (OBC)



OBC installation

INTRODUCTION

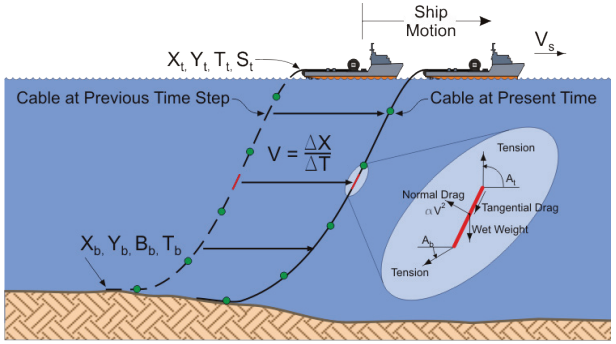
MakaiPlan Pro Seismic is a new cable installation planning and simulation software developed by Makai Ocean Engineering to meet the needs of the seismic Industry to accurately plan the installation and retrieval of Ocean Bottom Cables (OBC) in mid- and deep waters. MakaiPlan Pro Seismic runs on a PC under Windows 7 or XP operating system.

MakaiPlan Pro Seismic builds on our market-leading simulation and installation planning software MakaiPlan Pro, which has been successfully used for planning installations of military arrays, telecommunication and power cables over the last 20 years (see Makai's brochure on MakaiPlan Pro for details). MakaiPlan Pro Seismic allows the user to perform powerful and precise 3D, dynamic simulations of the cable installation and retrieval. The operator can quickly simulate an entire cable lay in advance and in his office at 25 to 50 times faster than real-time. The simulations can be used to test the feasibility of the planned lays, make equipment selection, train cable engineers, pre-lay and post-lay analysis, and create a detailed Ship Plan for installation. A detailed analysis and simulation is valuable to best understand and plan for dynamic cable situations that occur during speed changes, starts and stops, and hydrophone body deployments.

Makai Ocean Engineering
makaiseismic@makai.com
Phone 1 808.259.8871
Fax 1 808.259. 8238

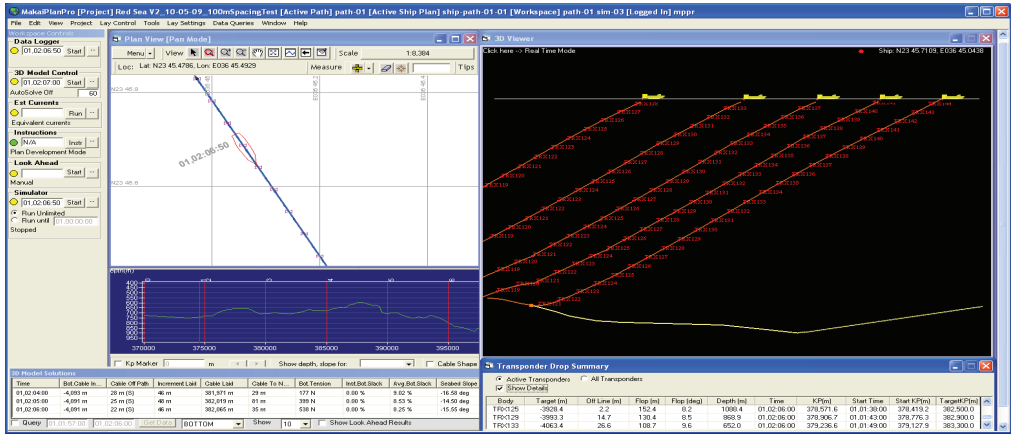
CABLE LAY SIMULATIONS

The heart of MakaiPlan Pro Seismic is a detailed and rigorous 3-D dynamic cable model. The model accurately computes the geometry and forces acting on the suspended cable, and the cable touchdown position and bottom tension (or slack). This is accomplished by taking into account cable characteristics (size/weight), ship velocity, bathymetry, currents, feedback from transponders attached along the cable, and all other parameters affecting the dynamic position of the cable. MakaiPlan Pro Seismic includes a state-of-the-art cable installation and retrieval simulator that, coupled with the cable model, can simulate the installation of an entire cable in order to compute the realistic cable touchdown conditions when a given ship plan is followed. Makai's model has been rigorously tested and calibrated at-sea. As a result, the cable touchdown conditions – location, slack, tension and even bottom dragging – are confidently computed.



Dynamic 3D cable model used by the control system.

The software changes the focus of cable deployment and retrieval planning from the cable condition at the vessel (current practice for OBC) to its condition on the seafloor. It allows cable installers to focus on the most important issue in any cable lay: the condition of the sensors on the seafloor. The sophisticated cable model can predict the result of any cable payout or ship action on the cable seafloor conditions. The result is a major improvement in the installer's knowledge of the cable condition on the seafloor and in his ability to predict and control touchdown conditions.



Screenshot of MakaiPlan Pro Seismic running a simulation.

INSTALLATION/RETRIEVAL PLANNING & EQUIPMENT SELECTION

Installation planning and equipment selection is achieved by running computer simulated cable lays in the office to model the effects of changes in cable type, equipment, procedures and environmental conditions of the lay. Such simulations allows for detailed analysis/selection of the equipment, techniques and data inputs required to safely and reliably lay/retrieve the cable along the planned route. These simulation results help contractors to fully understand the complexities of the operation well before they have to go to sea, and help them to more accurately bid a project. Operators can make all their mistakes in advance on the simulator when they can be easily corrected and before they become costly at-sea disasters. The system can simulate real world problems such as ship navigation errors, variations in ship and cable payout speed, unobserved changes in ocean currents and bathymetry.

This capability allows users to answer important questions before going to sea, such as:

- Is it necessary to measure currents in real time to achieve the desired placement accuracy and tension control?
- Do we need to attach transponders on the cable to achieve desired accuracy and how often?
- What is the fastest speed the cable can be installed and still achieve the desired accuracy in terms of sensor placement and tension control?
- What is the fastest retrieval rate possible without exceeding the maximum cable tension?
- How much can cable dragging on the seabed be minimized by using feedback from transponders attached to the cable and/or by measuring currents during the retrieval operation?

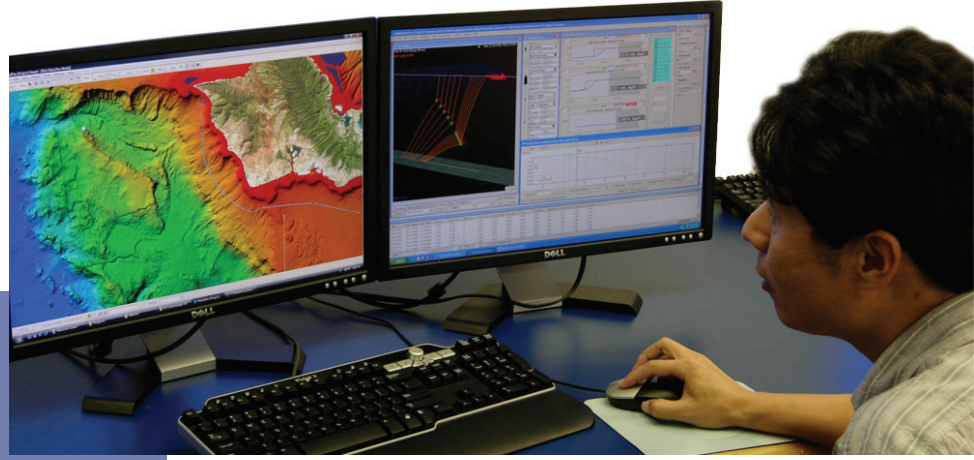
CABLE ENGINEER TRAINING

The system has proven to be an excellent training tool, and it provides operators with as much experience as possible under different deployment scenarios before the real lay. The cable lay/retrieval simulations allow the operator to become familiar with how the cable behaves (e.g., response times and cable shapes) under different environmental conditions and help to develop a clear understanding of efficient techniques for sensor placement/retrieval and bottom tension/slack control. In addition, the operator can be trained in dealing with contingency situations. For example, under a sudden cable halt in payout, what should be done to prevent undesirable bottom cable motion and tension?

DEVELOPING A SHIP PLAN

MakaiPlan Pro Seismic can create a ship plan that would be followed during the OBC installation. This is a detailed set of ship and cable payout instructions for installing the cable along a given seafloor cable path. Initially, a preliminary ship plan is generated quickly and automatically based on simple steady-state approximations to the cable installation process – it provides a first-cut at a ship plan, which is useful to estimate the time for the installation and retrieval operations.

The installation/retrieval operations can then be simulated in more detail and refinements can be made to the preliminary ship plan. With a dynamic 3D simulation of the lay, you look at the entire operation, minute-by-minute, and compute seafloor slack/tension, and location along all or portions of the route. The analysis can be accomplished at 25 to 50 times faster than real time. Sensor touchdown events, startups, slowdowns and stops can be graphically reviewed and adjustments can be made to the preliminary plan to compensate for these unsteady events and a detailed ship plan can be developed. During this process, the user can find ways to optimize the operations and minimize overall time spent at-sea.



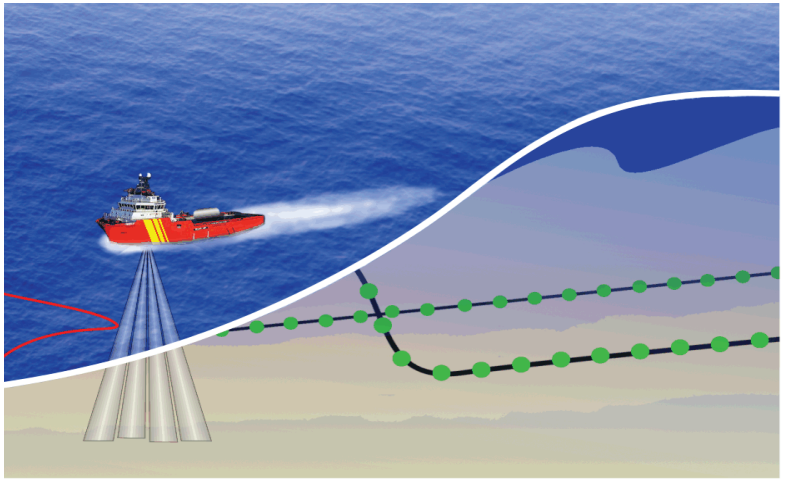
Student in training lab running MakaiPlan Pro Seismic.

USING OCEAN CURRENTS

MakaiPlan Pro Seismic can generate and use time varying and depth varying current profiles in the simulated installation/retrieval runs to accurately represent the ocean currents you would expect at the site. The user can then evaluate how these currents would affect the accuracy for the placement of the OBC sensors as well as their effect on the tensions and cable dragging during retrieval. With these results, the user can evaluate whether the use of an Acoustic Doppler Current Profiler (ADCP) is warranted during the installation in order to achieve the desired accuracies.

SIMULATING TRANSPONDERS

In typical OBC installations, transponders are placed at regular intervals along the arrays. Having accurate position measurements of transponders attached to the cable can significantly improve the overall cable and sensor placement accuracy. In MakaiLay Seismic (see Makai's brochure on MakaiLay Seismic for details), the transponder data can be utilized by either directly forcing the transponder positions on the cable shape or by passing the measured transponder positions though a



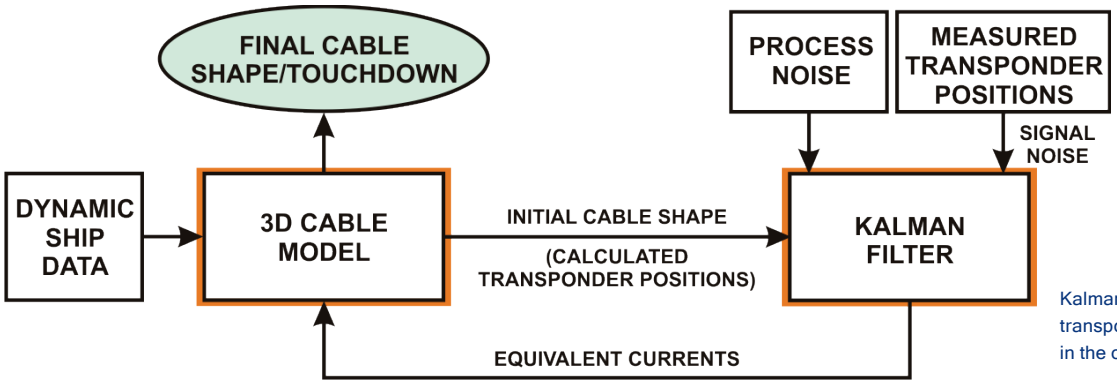
Using an ADCP to measure currents versus depth in real time.

Kalman filter to estimate the ocean currents acting on the cable and improve the cable shape and touchdown computations. This is particularly helpful when ocean currents are not being measured or when the quality of the transponder position data is not very high.

MakaiPlan Pro Seismic can simulate transponder data and then simulate the use of transponders just like they are used in MakaiLay Seismic. This is possible because MakaiPlan Pro Seismic runs an additional 3D cable model in the background. For example, if you want simulate how accurately an installation can be made without measuring currents and just relying on transponders, MakaiPlan Pro Seismic model will run a simulation in the background with ocean currents incorporated and will generate the transponders positions from the cable shapes of this background model. In the actual simulation, no ocean currents are used and just the transponder data are used. These simulations are helpful in making decisions about the data quality and placement frequency of the transponders.

RETRIEVING CABLE

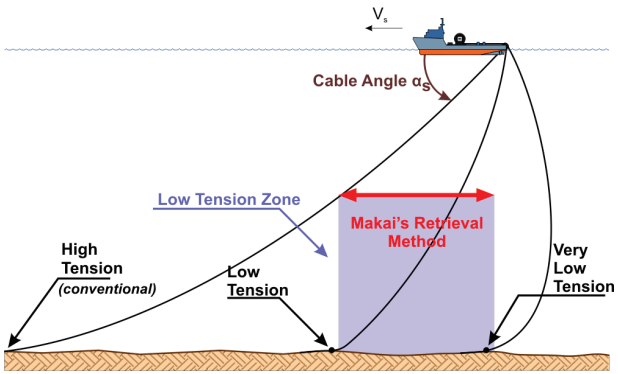
MakaiPlan Pro Seismic's 3D cable model has been optimized for retrieval of cables. As a result, the software can now model more accurately the cable-seabed interactions and cable being dragged as a result of the seabed cable tension. Having an accurate knowledge of the cable conditions on the seabed at all times allows for cable retrieval with lower seabed tensions, which in turn decreases cable dragging on the seabed. This helps minimize cable fouling with bottom outcrops and cable abrasion, thus providing longer array life.



Kalman Filter incorporates transponder positional data. in the cable model solution.

POST-INSTALLATION ANALYSIS

MakaiPlan Pro Seismic can be used to simulate in detail a cable installation after the installation is completed. This post-installation analysis provides useful information to further optimize future installations and to avoid repeating errors made at-sea.



Makai's retrieval method avoids high tensions which can damage the cable.

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:

Makai Ocean Engineering

PO Box 1206

Kailua, Hawaii

96734-USA.

Phone: 1 808 259-8871

Fax: 1 808 259-8238

makaiseismic@makai.com www.makai.com

Makai Pier