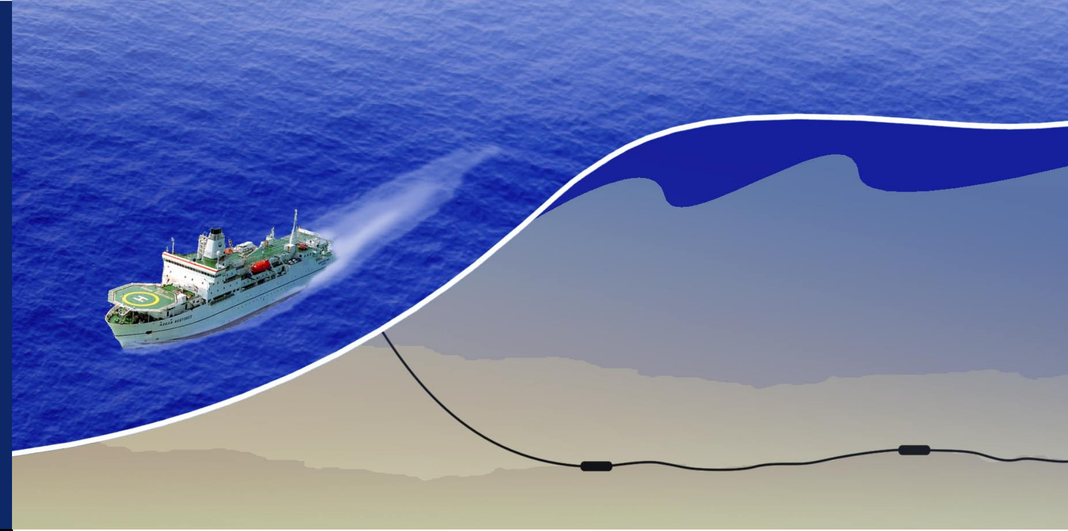
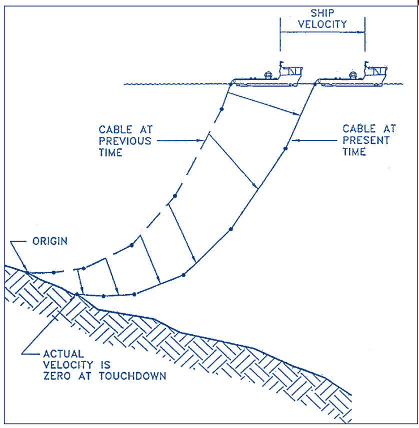
MakaiLay

Submarine Cable Management Software





MakaiLay *for Submarine Cable:*

- **Planning**
- **Simulating**
- **Logging**
- **Monitoring**
- **Navigating**
- **Controlling**
- **Reporting**

MakaiLay | A Summary

This brochure describes the main features of MakaiLay, a comprehensive PC-based software program designed specifically to install submarine cables with the highest level of accuracy and reliability possible today. Described are the features of MakaiLay, how it works, and details on its validation and testing.

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MAKAIPLAN PRO

MakaiPlan Pro allows the user to perform powerful and precise 3D, dynamic simulations of a submarine cable installation. Using the 3D simulator, the installer can quickly simulate an entire cable lay in advance and in his office. By simulating the installation in detail at 30 to 50 times faster than real-time, a complete lay can be completed in one to two days. The simulation provided by *MakaiPlan Pro* gives a detailed understanding of cable behavior, can be used for training cable engineers, can be used for pre-lay and post-lay analysis, and can be used to create a detailed Ship Plan for installation. A detailed simulation is valuable to best understand and plan for dynamic cable situations. If used before a cable lay, the simulation is a thorough advance check; errors can be corrected before they become at-sea mistakes.

MAKAILAY

Makai Lay extends the features of *MakaiPlan Pro* to a practical at-sea working system to accurately manage and control the installation of the submarine cable. The major emphasis in the development of *MakaiLay* has been in the accuracy and reliability of installing the cable on the seabed as specified by the cable route plan. *MakaiLay* is the primary subject of this brochure.

MakaiLay Functions: MakaiLay is a single comprehensive program that runs on a PC under a Windows operating system. MakaiLay provides the following functions in the cable installation process:

Planning: *MakaiLay* incorporates most of the features of *MakaiPlan Pro*. It works in a powerful Geographical Information System (GIS) framework allowing the user to easily display and accurately contrast geographical-based data. The cable route can be readily viewed as geographical entities properly positioned on navigation charts, route survey data or other GIS data. The user can create and edit a Ship Plan.

Simulating: The heart of *MakaiLay* is a detailed and rigorous 3D dynamic model of the cable as it is being deployed on the seabed. *MakaiLay* can be used at any time to simulate a cable lay in detail. Simulation is extremely valuable to visualize exactly what is going to happen to the cable during any installation. It can be used for planning dynamic at-sea operations and for training cable operations personnel.

Data Logging: *MakaiLay* logs all data critical to the cable installation and can log any other available digital data as well. *MakaiLay* creates a very complete and detailed record of the cable operation.

Monitoring: *MakaiLay* computes accurately and in real-time the shape of the cable between the ship and the seabed and computes a reliable record of touchdown conditions. At all times, the operator knows what the cable is doing and the impact of any ship or cable payout operation on cable touchdown conditions. *MakaiLay* shows detailed 3D graphics of the current and past cable shapes.

Navigating: *MakaiLay* can guide the ship along the Ship Plan by working directly with a DP system or by displaying guidance to the helmsman. The navigation display provides ship guidance information and optionally shows any or all other related information in a GIS environment.

Controlling: *MakaiLay* is very flexible in its options for controlling cable payout and ship course and speed. *MakaiLay* contains the most powerful algorithms available today for controlling seabed slack, tension and/or position.

Reporting: *MakaiLay* provides extensive documentation on the cable lay both in detailed data logs and in GIS as-laid databases. Data retrieval, display and compatibility with other programs are very flexible. As-laid user-configured charts, tables, 3D images and summaries can be retrieved at any time during the lay by either the main computer or by remote stations throughout the ship. *MakaiLay* distributes data as needed to client computers located anywhere on the ship.

THE *MAKAILAY* CREATORS

The Cable Division at Makai has 20 years of experience dedicated to the development and use of software for the precise control of submarine cable installations. Makai's team has taken on challenging cable installations that would be impossible to install with conventional cable-laying techniques. While responding to these challenges, Makai's cable experts recognized that precise control required a precise understanding of cable behavior and the team developed a tool to provide that understanding.

From this fundamental ability to accurately analyze cable behavior, Makai has developed a complete system for simulating, logging, navigating, monitoring, controlling, editing and documenting a cable operation. *MakaiLay* is the second generation of software used by Makai for at-sea cable control. The cable team at Makai consists of professional engineers programmers dedicated to quality and accuracy. All of our team leaders have extensive at-sea experience on cable ships and know very well both the theoretical and practical side of cable laying.

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

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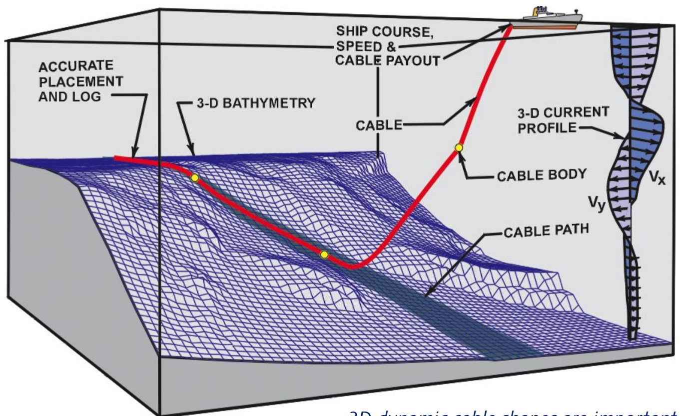
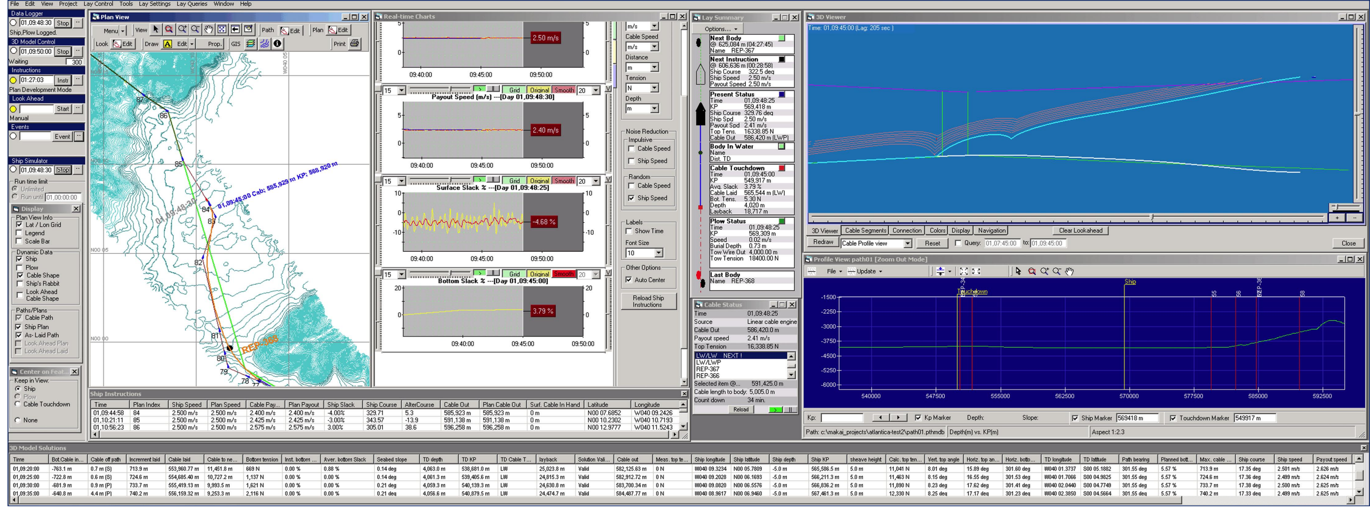


3D dynamic cable shapes are important



HOW MAKAILAY WORKS

First, it is important to understand that the primary purpose of a cable management system is to assist in placing the cable on the seabed. The installer is responsible to lay the cable along a given path at a designated level of bottom slack, safely and in a minimum amount of time. While he can easily control the ship end of the cable, he is ultimately responsible for the other end. What happens with the cable between the ship and the seabed is the major unknown in cable laying. No matter how simple or complex, all cable payout methodologies incorporate some method of describing the cable shape between the ship and the seafloor. The degree of success or failure is directly related to the ability to adequately compute cable touchdown conditions.

All cable control systems have the ability to compute cable "shapes" and use those shapes in controlling cable payout or slack. Various methods of computing cable shapes can, at first glance, look identical. However, cable shape computation is a complex issue. Cable shapes are computed based on numerical models. Concepts such as "real-time", "dynamic", and "3D" can be quite casually used. The real test of the quality of the numerical model is how rigorous it is in computing cable shapes. A good model will predict behavior that matches well with a real cable.

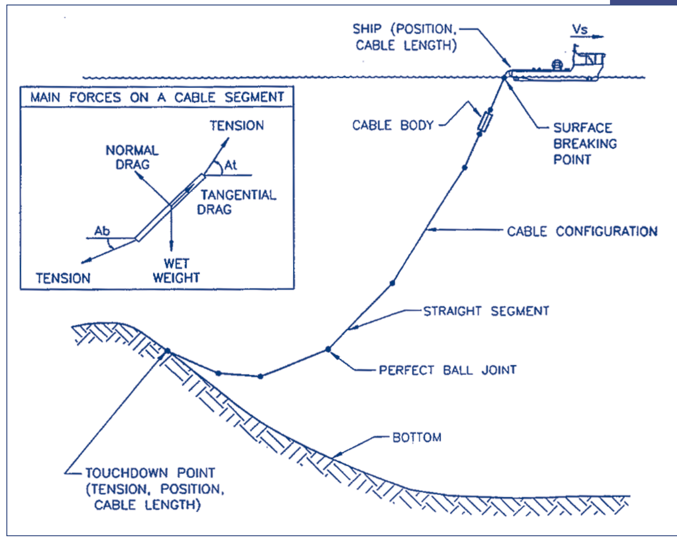
For the past 40 years, many cable models have been developed based on an adaptation of steady-state cable principals developed by E.E. Zajac of Bell Labs in 1957. Zajac did a fantastic job at defining steady-state cable physics, but his approach was limited by the computing restrictions of his day. Zajac solutions are simple to understand, simple to visualize (defined by cable angle) and have been used by cable engineers for years. Because they are based on steady-state principles, these models are fundamentally prohibited from rigorously computing cable shapes that are non-steady–a common occurrence during cable lays. Today, thanks to the digital computer, we no longer need to make these approximations. Cable installations are non-steady for roughly between 50% and 100% of the laying time. Cables are non-steady if their shapes vary over time, and this will occur under a variety of conditions. The ship speed often varies, cable payout is not always steady, the course is not always straight, and the cable catenary often contains sensors, repeaters, and splices. An accurate model that can handle unsteady solutions is therefore needed for much of the cable lay.

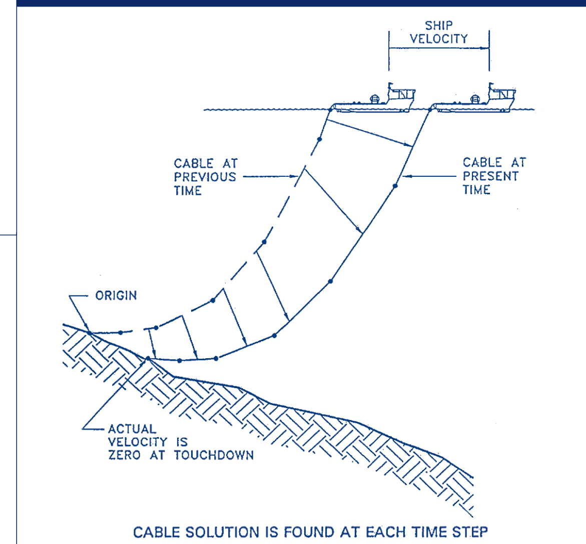
The heart of *MakaiLay* is a very thorough and rigorous mathematical model of the cable located between the ship and the seabed. Makai's model is dynamic, three-dimensional, fast and rigorously adheres to the principles of cable physics. If the *MakaiLay* input data are correct, the computed cable shape is extremely accurate–under any conditions. *MakaiLay* does not distinguish between steady state and transient conditions. The *MakaiLay* model treats all solutions identically and can compute the proper shape under any condition. The fundamental static and dynamic physics is contained in the model, so the analysis does not change under dynamic conditions and the accuracy remains steady. There is no need for concepts such as “transient slack” or manual adjustments for other unsteady situations.

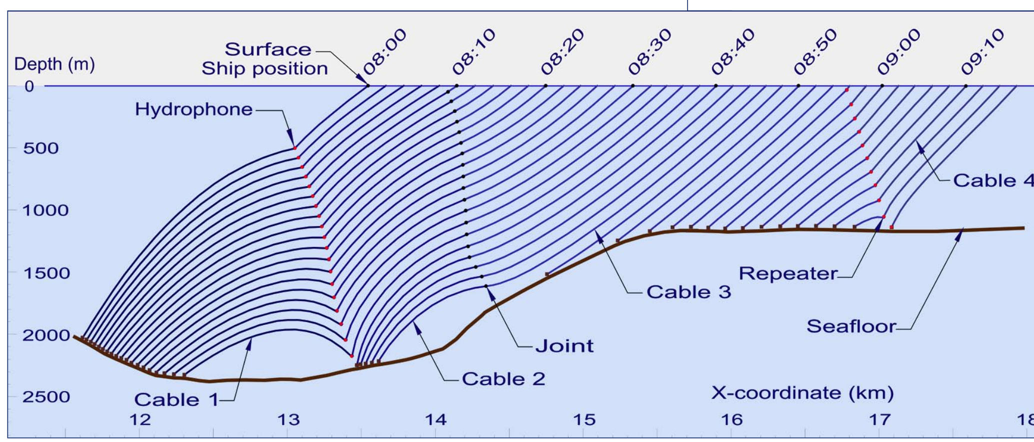
Makai’s cable analysis can compute solutions that are needed during practical cable laying conditions. MakaiLay can easily accommodate currents because they are simply part of the overall physics of the lay. Current data can be measured using an ADCP, and this is used for more challenging cable installations. MakaiLay’s model can also compute cable solutions where there is either bottom slack or bottom tension. MakaiLay can make a smooth transition from one solution type to the other, just like a real cable.

A very important aspect of cable analysis and modeling is that a real cable is not unstable under dynamic conditions–it smoothly and gracefully follows any dynamic change in the deployment. So, a good model should do the same. If a real cable can’t jump about the seabed, the modeled cable should not jump either–if it does, there is a fundamental error in the model.

Makai’s model shows a continuous cable stepping smoothly through time with end boundary conditions matched and shapes that are physically reasonable based on prior time steps. The smooth nature of the output is a result of proper modeling of the cable lay physics.







A time-stepped profile of a single cable lay over an irregular terrain. The cable is comprised of four different cable types, a joint and two heavy in-line cable bodies. This installation could not be described in steady-state terms.

MAKAILAY

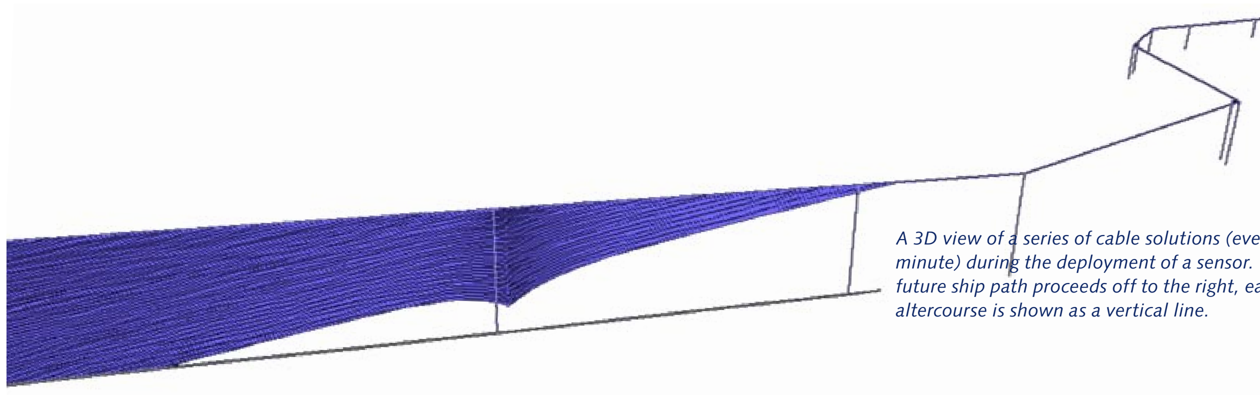
REAL-TIME MONITORING

MakaiLay monitors the lay and provides real-time feedback of the cable shape and touchdown conditions during the lay. *MakaiLay* calculates in real time a cable shape that provides where the cable is being laid, its bottom slack/tension and the location of any attached cable bodies. It interfaces with vessel instrumentation to receive the necessary data to make these calculations.

MakaiLay computes typically every minute the shape of the cable moving through the water column. This is not an approximation or a simplification of the cable shape. It is a detailed and meticulous 3D cable computation. The mathematics used in this computation are described in the “How *MakaiLay* Works” section.

Cable shapes in the water column are displayed in three dimensions and the cable slack is computed. If the computed slack goes to zero, the program computes bottom tension. If the tension goes high, the cable on the bottom may be dragged across the seabed (changing prior touchdown locations and slack). The software computes cable shapes under the following conditions:

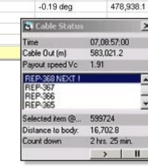
- **When placing a cable with slack on the seafloor**
- **When placing a cable with tension on the seafloor**
- **When deploying inline cable bodies on a cable with bottom slack or tension**
- **When stopping and restarting a cable lay**
- **When recovering a cable**
- **When lowering or retrieving a cable free end**



A 3D view of a series of cable solutions (every minute) during the deployment of a sensor. The future ship path proceeds off to the right, each altercourse is shown as a vertical line.

MakaiLay has the option to incorporate real-time current measurement data into the cable modeling and analysis. Adding accurate currents in some cases improves the cable shape computations and the touchdown predictions.

The monitoring system stores all computed cable shapes, dynamics, and touchdown conditions for each solution generated. These archival data are sufficiently complete so that an accurate recreation of the entire lay can be performed in a post-lay analysis. As a minimum, these archival data include: all program input data, all cable solutions and all ship and cable payout instructions.



Makai Lay provides detailed records of each cable solution. Right side: The status of the cable payout is shown, providing details on each cable body and the time to overboard.

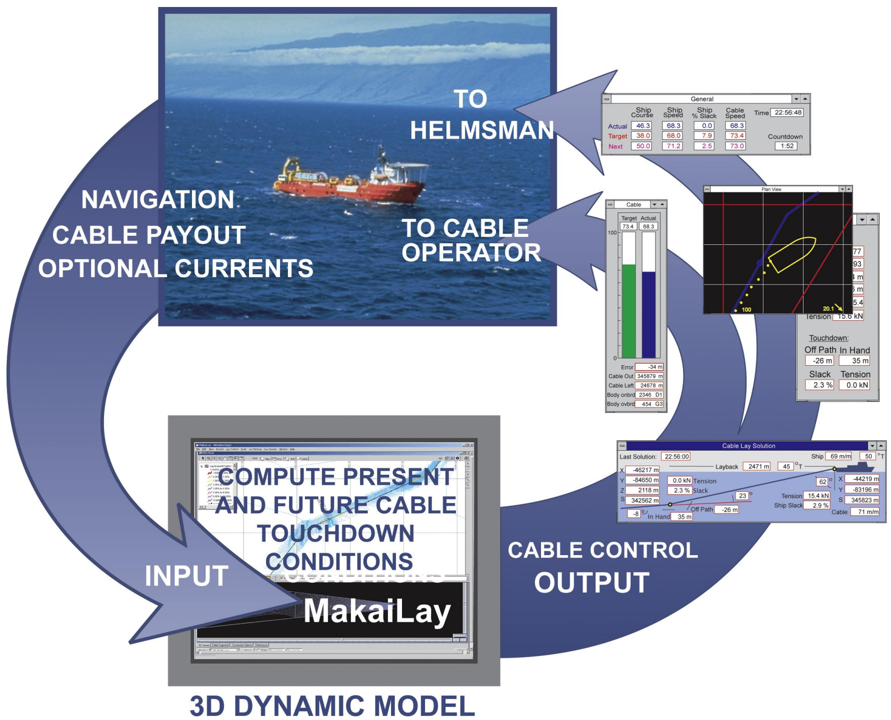
THE CONTROL OPPORTUNITY

Incorporated within *MakaiLay* is the most thorough and accurate analytical cable model available today. *MakaiLay* can be used to reliably and practically determine the shape of the cable as it is being lowered to the seafloor and to determine touchdown conditions.

By carrying the *MakaiLay* at-sea analysis one step further, this same mathematical model can be used to determine future cable shapes. Therefore, touchdown conditions in the immediate future can be reasonably predicted by the model. Having such a prediction is like a having a crystal ball – corrections can be made to the installation procedures to avoid unde sirable touchdown conditions.

The three most important touchdown properties for cable installation are slack, tension and position. For most telecommunication cables, slack is the most important goal, tension is undesirable (if slack is satisfied, there will be no tension), and position is of secondary importance. For telecommunication cables, *MakaiLay* is used to predict and direct cable payout such that bottom slack is controlled at the RPL specified levels.

Power cables are installed with low levels of bottom tension. *MakaiLay* solutions are equally valid for a cable being laid under bottom tension.



The control loop: Ship data is logged, processed in the MakaiLay model and future touchdown conditions are computed. Instructions are issued to the helmsman and the cable operator.

Some cables require accurate placement on the seabed. In these cases, *MakaiLay* can be used as a real-time control system to direct the ship along an optimal course in order to keep the bottom cable near the desired bottom path.

In other cases, cable operations require a trade-off between placement accuracy and cable operation time. *MakaiLay* can optimize this trade-off so that the amount of time to install and recover cable is minimized while the operation stays within its design specifications.

The section entitled "*MakaiLay* validation" illustrates several actual cable installations where the control capabilities of *MakaiLay* were demonstrated.

WHY CONTROL?

If a cable installation accurately follows a detailed and proper Ship Plan, why is there a need for real-time control? Basically, no installation ever follows the plan exactly and many deviate dramatically from the original plan. The ship speed is never exactly according to the plan, and cable payout likewise does not follow the plan perfectly. Often, there are unplanned stops and contingency situations that could not have been anticipated. Equipment failures and weather often dictate major variations from the original plan. Once the ship conditions are not as anticipated, how should the cable be handled?

MakaiLay provides graphical output showing actual and desired cable payout rates and distances.

With real-time control and the full power of the *MakaiLay* model at sea, the correct adjustments to the plan can be easily and reliably made before they become problems. Cable operations can be monitored and reasonably controlled under nearly any real-time condition.

Seafloor Slack Control:

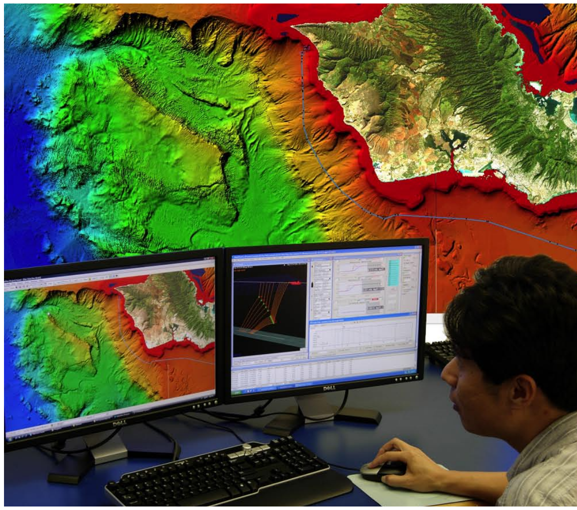
MakaiLay has the ability to control cable payout speed in order to actively control the cable slack on the seafloor. *MakaiLay* uses the 3D dynamic monitoring algorithms to predict the near-future cable shapes and touchdown conditions. It computes the appropriate cable payout speed and/or ship speed in order to achieve the desired cable touchdown conditions.

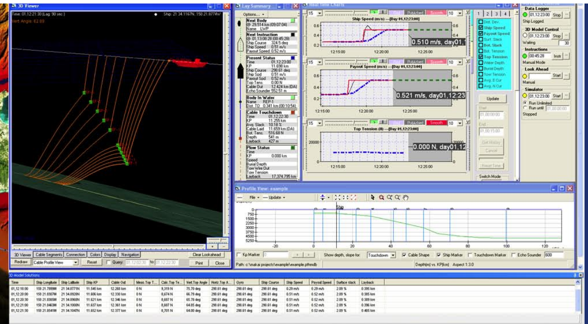
The system displays forecasts of the future cable shape profiles and graphs of future touchdown conditions, surface conditions, ship speed, and payout speed.

Seafloor Position Control:

For more advanced cable installations, *MakaiLay* can be used for position control of the cable. In this case, future forecasts, often looking an hour or more into the future, are used to optimize a set of ship instructions to keep a cable optimally aligned along a bottom path. Simultaneously with position control, *MakaiLay* provides seabed slack control.

For years, the cable industry harbored the concept that once a cable left the stern of the ship, there was nothing that could be done to control its placement on the seabed. This concept was a direct result of the steady-state cable models that were prevalent at the time. With *MakaiLay* in simulation mode, the capacity for position control can be quantified for any given installation. Makai has demonstrated real-time position control on several cable installations (see "*Makai Lay*: Program Validation"). The ability to make informed decisions at sea in response to any situation has dramatic impact on the reliability and accuracy with which cables can be installed.





MakaiLay in its simulator mode has all the feel and power of the system at-sea.

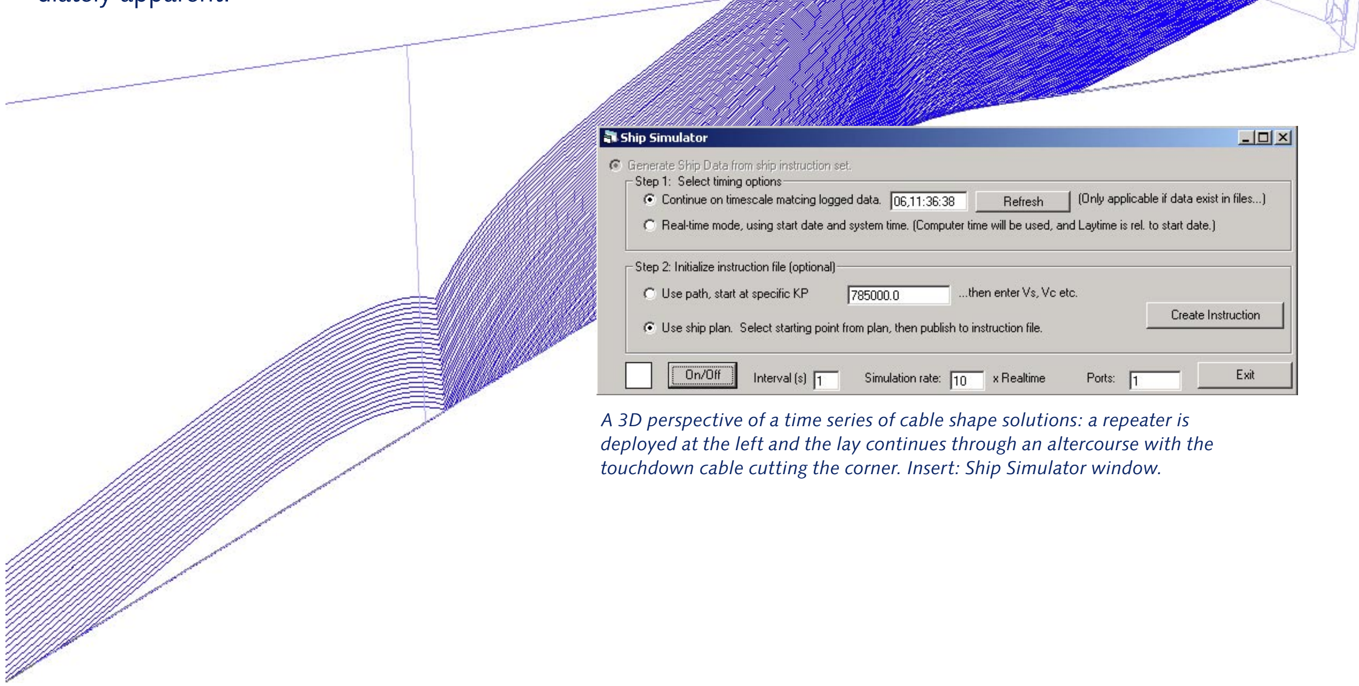
MAKAI LAY: SIMULATION

MakaiLay allows the user to dynamically simulate the complete cable installation (or any portion of it) either before or after the cable installation. The simulator is very valuable for:

- **Understanding how a cable will behave under certain conditions.**
- **Determine whether a cable can be installed using specific equipment or with a specific installation plan.**
- **Train cable operators by showing them exactly what the cable will do under specific ship and cable payout instructions.**
- **Create detailed Ship Plans in advance of a cable lay.**
- **Perform analysis of a cable installation after it has been completed.**

In simulation mode, *MakaiLay* behaves exactly as it does at sea. Detailed three-dimensional cable solutions are available to the operator.

MakaiLay can simulate cable installations much faster than real time. Depending upon the speed of the computer being used, cable lays can be completed at 30 to 50 times faster than real-time. A 30-day cable lay can therefore be completed in the office after one day of simulation. By quickly scanning the graphical GIS output record produced by *MakaiLay*, the success or failure of the cable placement will be immediately apparent.



A 3D perspective of a time series of cable shape solutions: a repeater is deployed at the left and the lay continues through an altercourse with the touchdown cable cutting the corner. Insert: Ship Simulator window.

MAKAILAY: HARDWARE

All the main processing of *MakaiLay* is performed on a single PC computer under a Windows operating system. A fully redundant backup computer operates in parallel. Data logging is done in parallel and cable solutions are computed on both machines simultaneously. The system can switch to 'the backup at any time. Makai recommends the following for the main and backup computers:

- **Intel XEON double processor or dual core, 3.00 GHz, with 2 GB RAM**
- **Two, 21" displays**
- **Graphic card with 128 MB (dual monitor capable)**
- **RAID Configured hard drives**
- **Microsoft Windows XP Pro, English Version**
- **Keyboard and mouse**
- **Parallel or USB and Serial Port**
- **DVD Read/Write**
- **A Multi-port serial card (32 ports) w/ RS232/RS422 jack panel**

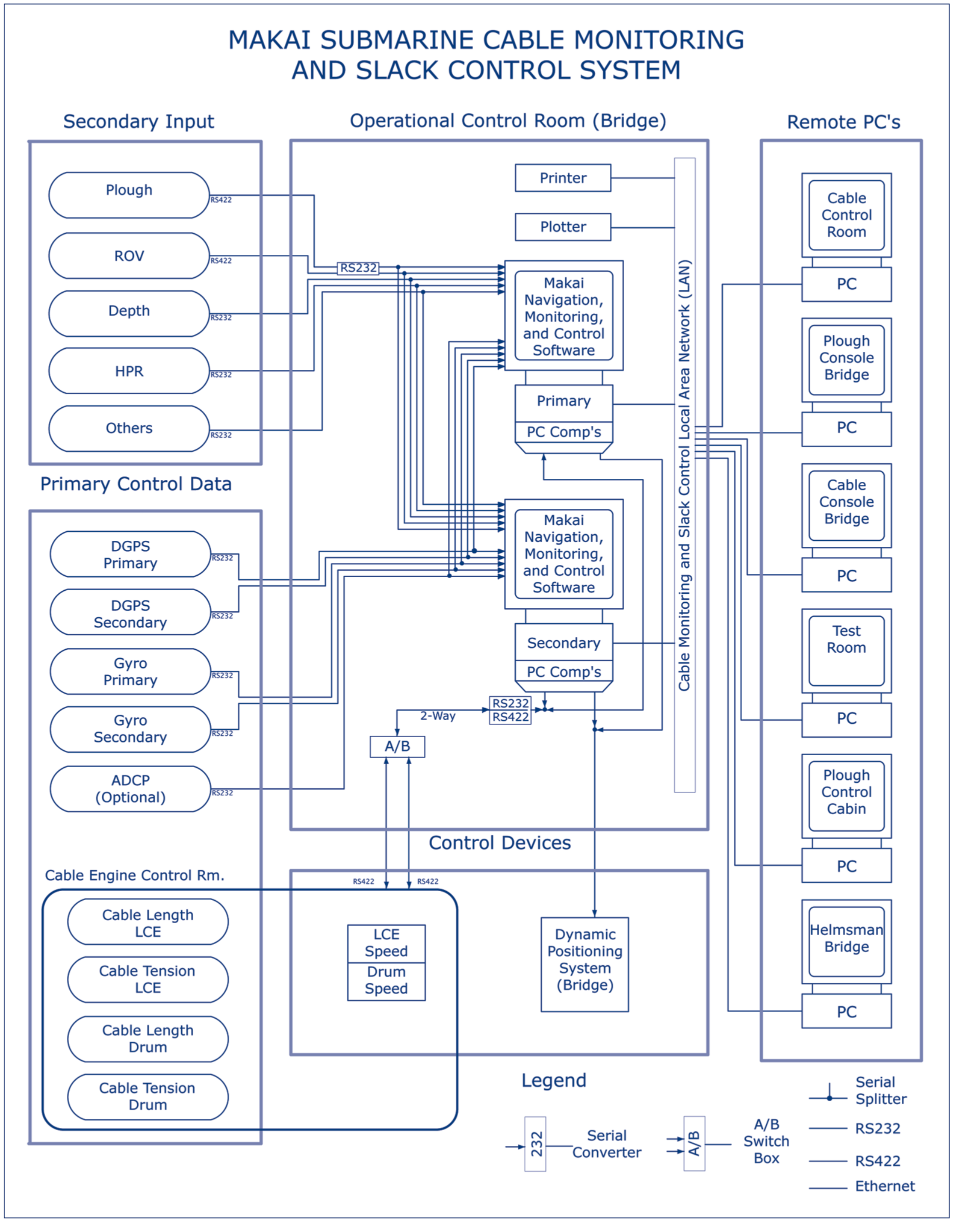
MakaiLay is quite flexible in terms of its configuration beyond the main and backup computers.

Input data can be provided via RS232-/422/485 or Ethernet connections. MakaiLay's standard configuration has 32, RS232/422 input ports and more can be added if needed.

Output from *MakaiLay* goes to the DP equipment and to the cable room – both locations receive instructions from *MakaiLay*. Those instructions can be sent by a direct wire (in case of automatic control) or via a Makai-driven display at each location (manual control).

There are client computers distributed throughout the ship; any number can be used. Client computers are stand-alone PC's with the *MakaiLay* client software.

The clients are connected to the main computers via a dedicated Ethernet. A plotter and printer can also be provided on the LAN.



A typical hardware configuration for MakaiLay is provided besides. Inputs are shown on the left, the main computers are shown in the center and the client computers are shown on the right.

MAKAILAY: PROGRAM VALIDATION

Makai Ocean Engineering has strived for excellence in understanding, analyzing, and performing submarine cable installations. We have been working on submarine cable projects since 1983 and formally created our Cable Division in 1988. Since that time, we have been involved in a variety of difficult cable installations, each of which has challenged, expanded and tested our capabilities. This section summarizes a few of those difficult cable lays in order to illustrate the capabilities of MakaiLay and Makai.

The following three cable installations describe the conditions under which *MakaiLay* was initially developed and the performance that is possible for:

- **power cables,**
- **lightweight cables while measuring currents, and**
- **lightweight cables without current measurements.**

PRECISION CALIBRATION

Hawaii Deep Water Cable: The Hawaii Deep Water Cable Program (HDWCP) was a research and development program co-sponsored by the U.S. Department of Energy and the State of Hawaii. The purpose of this program was to determine the technical feasibility of deploying and operating a submarine power transmission cable between the Island of Hawaii and the Island of Oahu. This project posed unique challenges never encountered by any previously laid power cable:

- **The cable route depth was 1920 m maximum, almost four times deeper than any previous power cable installation.**
- **Bottom slopes were as high as 44 degrees.**
- **Sea conditions were difficult; winds of 35 knots 35% of the time, 8 ft seas and surface currents of 2.9 knots.**
- **Because of the difficult bottom conditions, the acceptable cable path was quite narrow.**

The cable had to be laid to an accuracy of ±12 meters. Furthermore, the cable had to be laid at a very slight positive tension, no slack.

Makai coordinated and directed the route survey across the Alenuihaha Channel. We quickly determined that conventional cable laying techniques were not suitable due to the difficulty of the cable route and the accuracy required. It was necessary to have a better analytical understanding of the cable laying process.

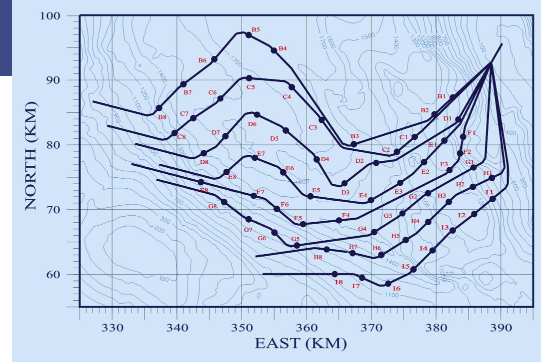
Makai developed a detailed analytical model that was sufficiently fast and sufficiently accurate to simulate, analyze and eventually form the heart of a real-time control system to lay this power cable.

In 1989, a test cable was laid along the Alenuihaha channel cable route. The cable was laid and recovered three times. This program was a precise test of the ability to lay cable. A long-base acoustic navigation grid was established on the seabed and transponders were attached to the cable to track its progress while laying. As-installed cable positions were measured within one meter. A manned submersible was used to inspect the cable on the seabed and to measure as-laid cable tension. Makai's Integrated Control System guided the cable ship (Flexservice III) and directed the cable payout. Cable solutions were computed in real time each minute and instructions issued every five minutes. Current profiles were measured with an ADCP and incorporated into the real-time solutions.

Alenuihaha cable route for three power cables.

The final result was that the RMS error for all portions of the 20 km of cable laid was 4.7 meters, con-siderably less than the 12 m goal. Bottom cable tension tolerances were equally well met.

This program demonstrated that cable lays could be carefully controlled with the use of the proper analytical tools incorporated into the control system. This program also validated the mathematical code used in those controls.



Makai´s contol system has been the key to success in laying complex, deep water cable arrays with multiple hydrophones where both placement accuracy and cable slack were critical control objectives.

PRECISION CALIBRATION

SOAR-2

In 1990, after the successful completion of the HDWCP, Makai Ocean Engineering Inc. was contracted by the U.S. Navy, Naval Facilities Engineering Command (Chesapeake Division), for the installation of the Phase II of the Southern California Anti-Submarine Warfare Range (SOAR II). The SOAR II project involved the deployment of a total of eight, 40-mile long cables, each having 8 hydrophones and several repeaters.

The cable lay took place in maximum water depths of 1,800 m, off San Clemente Island in California. The goal was to lay the hydrophones on targets (specific X and Y locations on the bottom) along cable paths with multiple abrupt turns. The maximum allowable error at the bottom was 90 meters. In this case, the cable not only had to follow a pre-determined path, but the bottom cable slack had to be carefully controlled in order to hit the targets.

Makai made several modifications to our software to accommodate lightweight cables, slack conditions, bodies (repeaters, transponders, hydrophones, etc.) attached to the cable, and a high degree of control on bottom cable slack.

During the cable lay Makai provided instructions to the ship and the cable engines every five minutes and stayed fully in control of the lay even during unplanned stops and severe changes in currents.

The project was very successful and a fully functional surveillance range is now in place. According to an independent survey completed by the U.S. Navy, the mean value of the hydrophone location from the target center was 46 m, half the maximum allowable error.

One of the most valuable services provided by Makai to the Navy was the pre-lay simulation and analysis (with the forerunner of MakaiPlan Pro). Makai was able to provide a shopping list to the Navy showing the equipment (and cost) required vs. performance expected, based on detailed modeling of the actual installation. The final results were slightly better than Makai's predictions.

In summary, a cable slightly lighter than today's lightweight telecommunication cable was deployed while measuring currents, and the average placement accuracy was 3.5 percent of water depth.

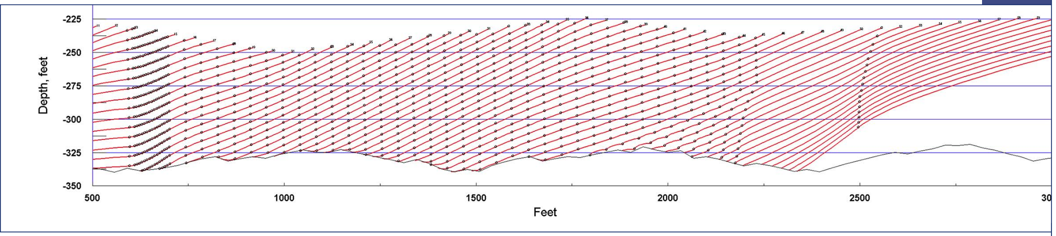
AURA - ACOUSTIC UNDERWATER RANGE IN AUSTRALIA

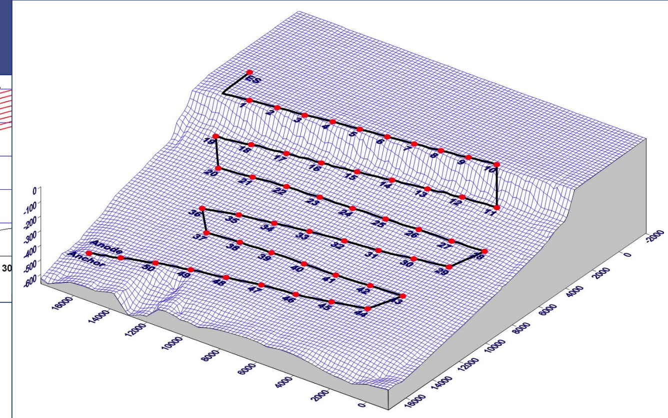
This project involved the use of a "ship of opportunity" to lay three cables, each 210 km long, in waters ranging from 10 m to 4,200 m deep. These cables contained several in-line hydrophones that had to be placed on specific targets along a pre-established route.

In 1992, Makai's simulator was used to determine: (a) the placement accuracy expected for a specific set of cable laying equipment and oceanographic conditions, and (b) the degree of cable slack control that could be achieved to minimize the total length of cable used and to avoid the use of additional expensive repeaters. In 1994, Makai's software was used to accurately place the hydrophones off SW Australia.

A post-deployment survey completed by the Navy determined that the final average placement error for the hydrophones was within 2% of the values predicted by previous simulations run with the Makai Simulator under deployment conditions. Despite using a "ship of opportunity" with poor sea keeping capabilities in high sea states, the use of Makai's at-sea control software allowed the cable layer to accurately control the placement of one of the cable systems in sea states 6-7 (sustained winds of 30 knots, 10 ft swells and 8 ft seas).

The absolute level of placement accuracy was 11% of water depth. Currents were not measured and were not incorporated into the control system. Cable weights were lighter than conventional lightweight cables used today and the hydrophones were equivalent in weight to modern cable splices. Installation





PTS Bahamas Tracking Range

speeds varied from 2 to 5 knots. During this installation, the control system also demonstrated that it could accurately control the cable deployment at ship speeds of 5 knots in depths of water of only 60 m.

CROSS-MODEL VALIDATION

Makai has also modeled for the US Navy the installation of micro cables 2 to 4 mm in diameter with multiple hydrophones. This is an extremely complex, numerically sensitive, and computationally challenging simulation. The Navy compared our results with Navy at-sea test results and the best software programs available in the US Navy. Our solutions had similar or better accuracy and Makai's solutions were computed at many hundreds of times faster than any competitive software.

PTS BAHAMAS

In 1997, Makai served as a subcontractor to the U.S. Naval Warfare Center for the installation of the Portable Tracking System (PTS). Initially, Makai was contracted to simulate the deployment operation using Makai´s cable lay simulator to determine the slack control and level of placement accuracy that could be expected during the deployment of the fiber optic cable and 51 in-line hydrophones that made up the cable system. These simulations were also useful to determine appropriate values of deployment speed in order to properly land the hydrophones on their targets even in the areas where abrupt course changes existed.

OTHER CABLE INSTALLATIONS

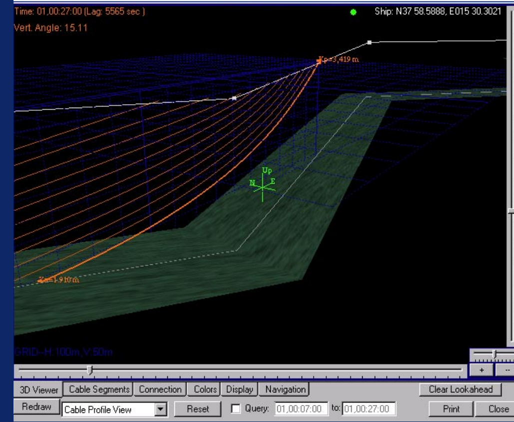
Makai's at-sea cable installation software has been used on numerous commercial lays and other military installations. Among them are:

- **Hawaii Deep Water Cable Program**
- **SOAR II (8 segments) - US Navy**
- **RANSTAR (3 segments) - Royal Australian Navy**
- **NTT (8 separate Lays) - Sagami, Izu, etc.**
- **JASURAUS**
- **PTS Bahamas - US Navy**
- **Gemini South and Gemini North**
- **Southern Cross (3 separate legs)**
- **Japan USA (3 separate legs)**
- **Hibernia (Segment E)**
- **TGN North & TGN Pacific Japan - US**
- **FLAG Atlantic and SAT-3**
- **Apollo North, Apollo South and C2C**
- **Far Ice Scotland - Iceland**
- **Med Nautilus Seg 9**
- **SMW-4 FALCON**

MAKAILAY OWNERS

• **Alcatel**	5 Vessels
• **Tyco**	2 Vessels
• **Elettra**	2 Vessels
• **NTT-WEM**	2 Vessels
• **Global Marine Systems Ltd.**	2 Vessels
• **Asean Cableship Ltd.**	2 Vessels
• **International Telecom Group**	4 Vessels
• **Dockwise**	2 Vessels
• **Solstad**	2 Vessels
• **SAIC**	2 Vessels
• **L3-MariPro**	1 Vessel
• **US Navy**	1 Vessel

MakaiLay 3.2 *Upgrade*



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TOP REASONS TO BUY

1. *MakaiLay* is the software of choice for cable installations with more than 150,000 route kilometers of cable laid worldwide.

2. Pre-lay planning with MakaiPlan Pro and *MakaiLay* lowers the risk of installation failure to a level where the planner is comfortable that "the cable can be properly laid" if everything goes as planned. However, quality of the actual installation will depend on the at-sea operations and how well the personnel can cope with last-minute changes and emergency situations. Cable installations rarely go exactly as planned, and *MakaiLay* provides at-sea personnel with the tools to deal with these changing conditions.

3. Cable engineers no longer need to spend countless hours at-sea trying to guess the shape of the submerged cable based on "simplified steady-state" or "simplified transient" approximation tools. *MakaiLay* provides operators with a more sophisticated and validated model to greatly enhance their ability to deliver a properly installed system.

4. At any point in time *MakaiLay* provides a meaningful 3D-Model of the submerged cable, including transients due to ship speed and course changes and those due to the effect of heavy optical amplifiers or cable transitions.

5. The operator can take advantage of *MakaiLay*'s AutoSlack feature to calculate how fast the cable engine should run in order to achieve target slack on the seabed. The operator may issue these instructions to the cable engine operator manually, via a graphic display, or the *MakaiLay* system can control the cable engine directly (on select cable engines).

TOP REASONS TO UPGRADE

MakaiLay 3.2 is the latest release of Makai's at-sea installation software and is part of a complete suite of cable lay software that includes MakaiPlan and MakaiPlanPro. The new MakaiLay includes many new features since its original release in 2001. Primary enhancements include:

1. The code has undergone years of testing during sea trials and real cable installations by more than 24 new and highly automated cable laying vessels used by the military and the major telecom companies throughout the world. Most of the feature improvements have been driven by user requests.

2. Runs on Windows XP.

3. The 3D Cable Model now has a Top Tension Control mode when laying cable under tension on the seafloor. The correlation between the numeric model and physical cable configuration is greatly improved since long-term cable length measurement errors do not affect the solution.

4. The *MakaiLay* software now uses a Kalman filter for the ship speed and positions used for display and cable engine control. The filter is based on a physical model of the ship motion and can be tuned to match the dynamics of the vessel in use and the present sea state conditions.

5. *MakaiLay* 3.2 is able to log (via serial cable) ocean currents measured in real-time with an Acoustic Doppler Current Profiler (ADCP). The current data are filtered and used by the 3D Cable Model to provide you with a more accurate cable shape and touchdown conditions during the installation.

6. Safer and easier change of active ship plan and improved tools to merge back to the original plan.

7. Warnings to operator if distance deviations or lag-times increase.

8. The GIS-Plan View can now be rotated to provide a more compact view of the vessel when it sails along track at any heading. A North arrow has also been added.

9. Direct control of cable engine speed is now possible with cable engines from select manufacturers. This feature is particularly beneficial during long transients where the ideal surface slack continuously changes. Manually controlling the cable engine speed during these conditions is operatorintensive and tiresome. A recent Trans-Pacific cable lay, in water depths in excess of 7000 meters, was deployed by MakaiLay with fully automated control of the cable engine.

10. The improved 3D finite element cable model can also be used for applications such as seismic arrays, flexible pipes, and deployment of scientific and defense arrays. Over 100 cable bodies and joints can now be simultaneously modeled in the water column.

11. New reporting charts provide fast access to long-term trends in ship speed, cable engine speed and lay status information over the last 24 hours. Trend charts can be printed and annotated for daily reports on lay operations.

12. New fast dynamic tools compute optimum pay-out rates during transients and emergency situations.

13. Improved utilities have been included for creating final As-Laid Positioning List in a GIS database and exporting results to AutoCAD compatible (DXF) format in various projections.

14. Improved RPL import utilities now exist which include bodies and slack changes.

15. The Helmsman's computer on the bridge can now display the target track line for the vessel based on the current MakaiLay instructions. By simply drawing a new route on the active MakaiLay workstation, the helmsman's computer will automatically show the updated track without any user intervention.

16. Switching between master and slave for the two MakaiLay workstations has been improved. The procedure is more efficient and requires less operator effort. The operator simply transfers all the remote MakaiLayClient users over to the secondary MakaiLay workstations by one mouse-click without any user intervention on the client computers.

17. The 3D Viewer now has the capability to display the bottom profile as a surface making it much easier to get a good 3D impression of the seabed. If a complete 3D terrain is available from survey data, selected portions can be shown in the 3D-Viewer.

18. The Track Status display now includes KP-based information such as "Distance to next AC" for selected vehicles such as ship or plow.

19. Annotations can be added to the GIS database based on positions of multiple vehicles making it much easier to annotate the map with plow related events.

20. MakaiLay 3.2 has more efficient file storage for lay data and is backward compatible with lay data from previous versions. The system has mechanisms for preventing diskfragmentation which can potentially lower computer performance.

21. Post-lay analysis of cable length measurement errors can be completed and final as-laid results can be presented based on factory lengths or as-measured lengths. At-sea repairs require editing of the cable assembly and these revisions are highlighted, so that the operator can doublecheck and verify the distances of the new sections before creating official as-laid results.

22. Multiple enhancements have been made in user interface and preparation of final reports.

23. Many of the user interface improvements and tools from MakaiPlan 3.2 have been incorporated.

24. Your competition has it, shouldn't you?

Each upgrade includes a one-year maintenance con tract. For more information and pricing, contact Makai Ocean Engineering.