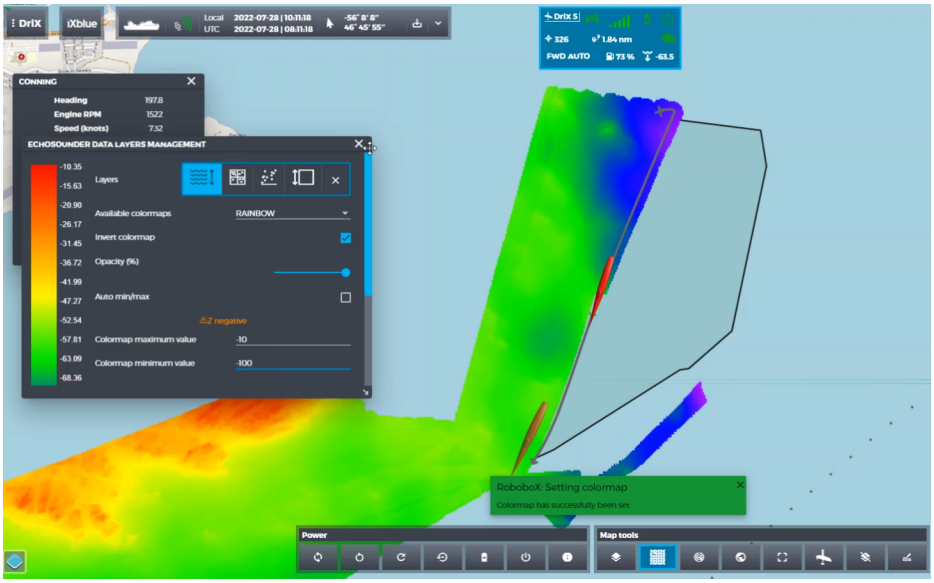
Assessing operational advantages for the new Autoline feature: comparison between survey projects performed in 2021 and 2022.

CHALLENGE
Reduce the overall survey time

SOLUTION
Implementing a new autoline feature

RESULTS
A 20% gain in the overall survey time thanks to the use of the "autoline" feature

Aiming to enhance and optimize hydrographic survey data acquisition, a new Autoline feature was implemented on the DriX USV. To evaluate the level of optimization of this new feature, let's compare two surveys conducted in 2021 (without Autoline) and in 2022 (with Autoline).



▲ DriX working in OTH, efficiently creating its own line planning using the Autoline feature

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1. INTRODUCTION

The new Autoline autonomous behavior feature optimizes DriX navigation for multibeam echosounder (MBES) coverage. As it navigates, DriX records a bathymetric swath, perpendicular to its direction of movement. To survey a given area, surveyors usually create a set of parallel lines so as to cover the full area.

If in the past, lines had to be created and imported in the DriX software, the ability of the DriX USV to interpret the bathymetric swath now allows it to optimize its navigation pattern, and therefore multiply the MBES survey efficiency and productivity. While the legacy method required considering safety margins in defining the spacing between lines, the new Autoline feature, allows DriX to optimize its trajectory from one path to the next with just the right overlap to ensure optimum survey data coverage.

To assess the Autoline feature and determine the level of efficiency it provides operators, this case study considers the example of two surveys that were performed in 2021 and 2022, in the same area off the French Island Saint-Pierre et Miquelon, and as part of the same project. In 2021, DriX conducted the survey lines based on a predefined line planning. In 2022, the autoline feature was used during the entire project.

A comparison of similar areas for 2021 and 2022 is shown below, considering survey acquisition, project preparation and adjustments during the operation.

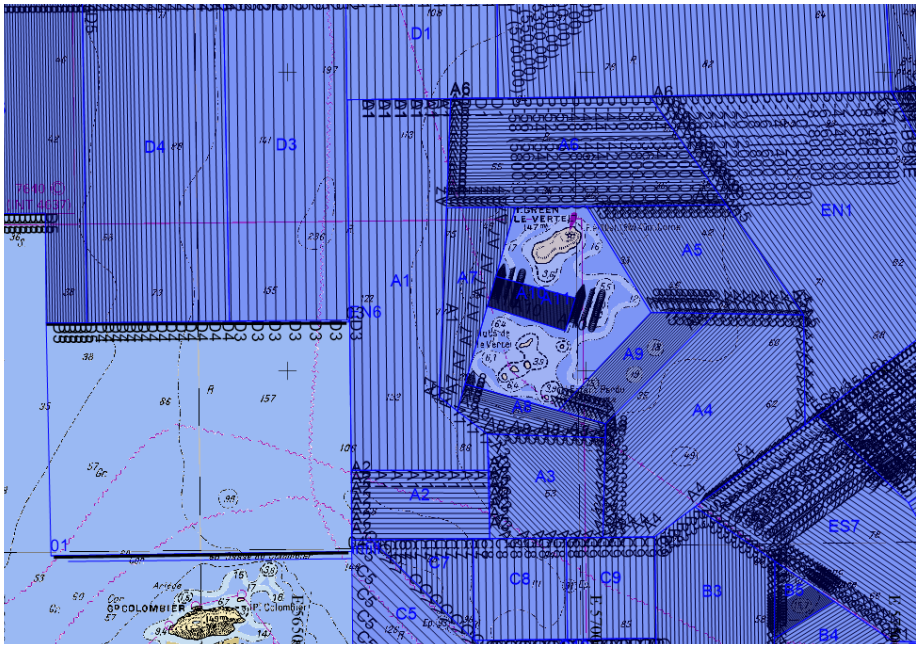
2. PRE-SURVEY PREPARATION

The survey planning aims to create the line plan that will be used by the survey vessel. It requires external information usually provided by nautical charts.

Even if this helps in accurately defining the overall survey duration, it represents a significant amount of time spent during the planning of the project, especially for areas with great depths variation.

Based on the specification of the survey (resolution, sounding density, ...), acquisition parameters are determined and from the nautical chart information, the line plan is generated.

To maximize efficiency, overlap between each multibeam echosounder swath should be minimum.



▲ DriX line planning example for 2021

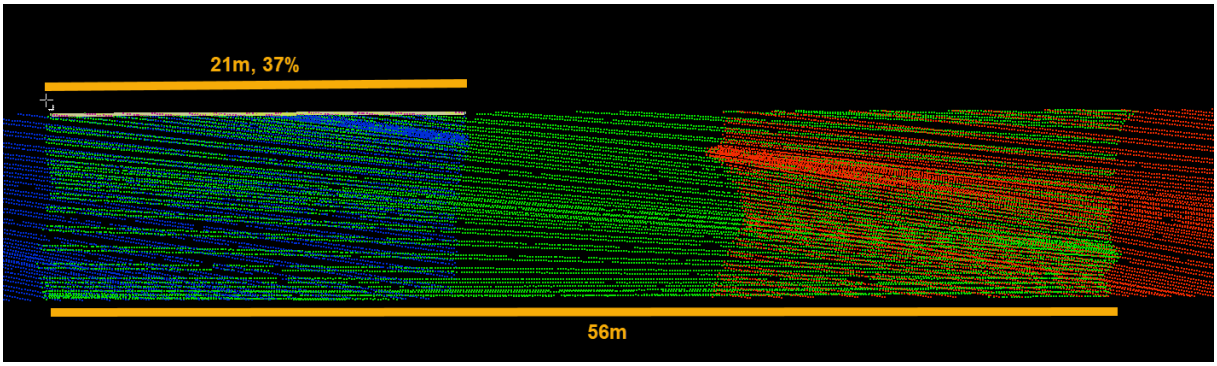
When using “Autoline” this line planning preparation is not required, only the creation of the acquisition boxes is done.

3. ON-SITE ADJUSTMENTS

Once the survey begins, two parameters need to be considered when calculating the line spacing:

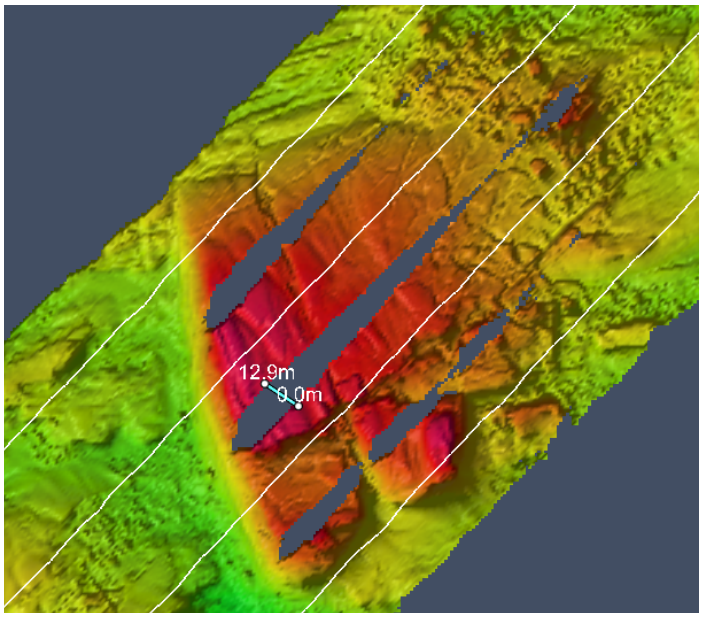
- The depth uncertainty. The absence or lack of accuracy concerning depth information (nautical charts), could indeed lead to two effects:
    - an underestimation of the depth and therefore a bathymetric overlap higher than required;
    - an overestimation of the water depth that will create holes in between the bathymetric lines.
- The tide. It changes the water depth during the execution of the survey and is usually considered during the planning phase. The nautical charts being based on Lowest Astronomical Tides, adding tides will create an underestimation of the water depth and will increase the planned overlapping and therefore reduce the survey efficiency.

Even in areas where depth is well known, variation of the seafloor creates areas where the overlap can be very significant. As an illustration, in the image below, each side line (blue and red) is overlapping by 21m the green line in the middle, creating an overall 74% overlapping of the section.



▲ overlapping example of three MBES lines

As another example illustrated below, 13m wide holes are created on shallower sections of the area due to a reduction of the swath. The opening angle of the MBES can be adjusted to try covering the reduction of the swath but this might not always be possible.



▲ Holes in dataset created by a shallower area

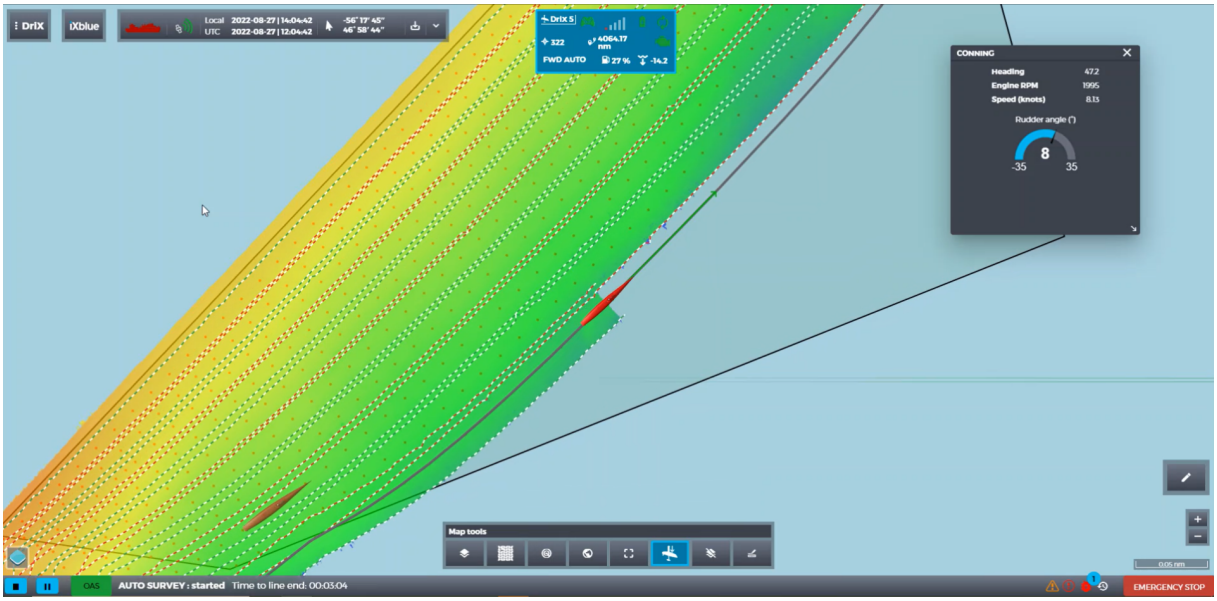
4. DRIX AUTOLINE

The Auto Survey mode, or Autoline mode, is based on the multibeam data being used by the DriX autonomy software. The following parameters can be adjusted from the autolinemenu:

▲ DriX's autoline access parameters

Operators do not have to prepare a line planning in advance. They only need to draw a survey zone and start the Autoline mission. The DriX software interface allows to import background files such as geotiff, shapefiles, or .DWG that can be used to define survey areas.

Once the mission begins, bathymetry recording automatically starts as the DriX USV enters the survey area and data is sent to the User interface. The Autoline autonomous behaviour keeps track of the swath outer beams positions and calculates the next path trajectory based on current and past swaths.



▲ DriX autoline view from HMI

Operators can also adjust the data overlapping between 0.5 and 50 %.

5. EFFICIENCY COMPARISON

The 2021 and 2022 surveys were conducted using the same acquisition parameters:

- DriX sailing at 7 knots
- Multibeam opening angle limited to 70° maximum (35° on each side)
- As little overlapping as possible to maximize coverage

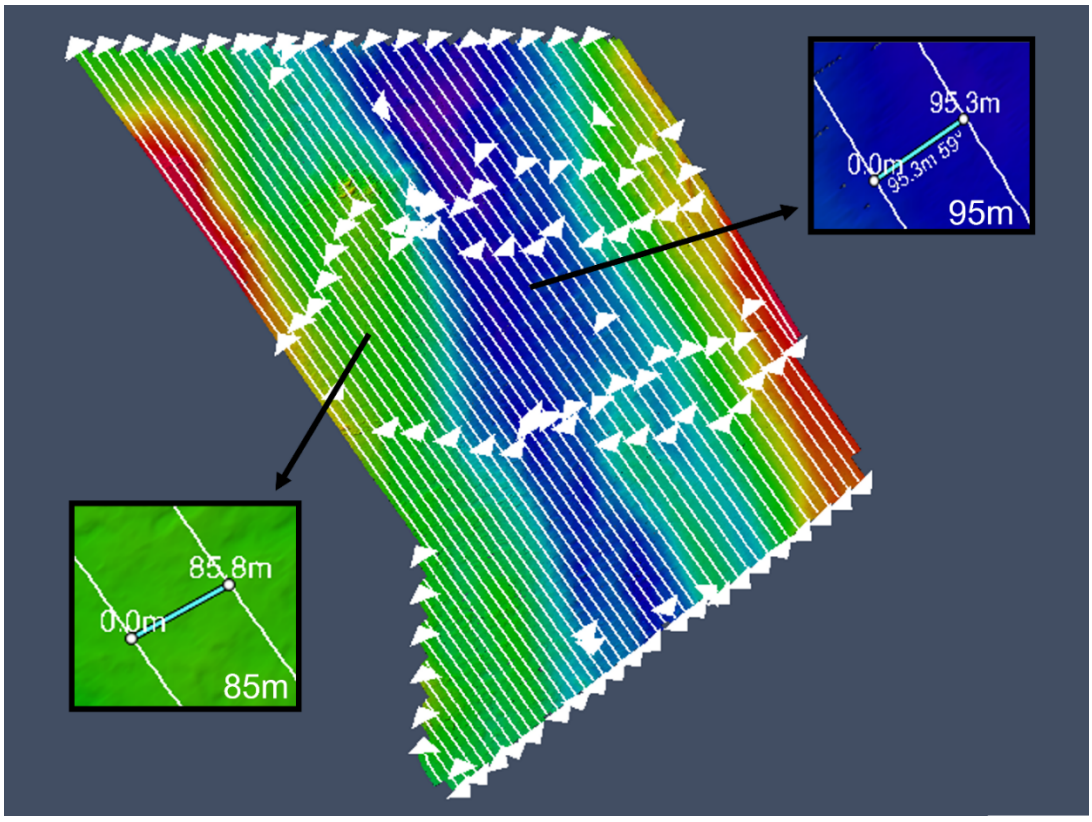
The analysis was conducted based on areas of the same size (16.5km2) in the same depth range (40m to 90m).

The sections below compare the two approaches in areas with approximately the same surface and same depth variations.

5.1. 2021 – LEGACY METHOD

The area chosen for the comparison is 16.5 km² wide.

The theoretical survey time estimated by QINSy was 16 hours and 37 minutes. This time was calculated using DriX trackplots after completing the area. The initial QINSy line planning counted 51 lines in total with a constant line spacing of 85 metres.



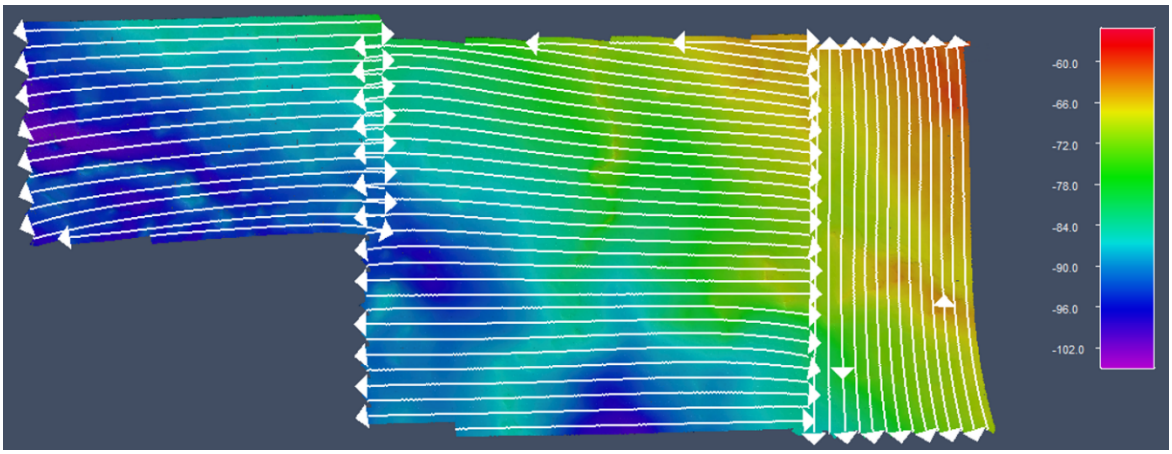
▲ Bathymetric map with overlayed acquisition lines (white) for 2021

However, as the on-site depth was greater than displayed on the marine chart, the line plan was adapted to have a variable line spacing between 85 and 95 metres.

As a result, the area was surveyed in 48 lines.

5.2. 2022: DriX Autoline

The area chosen for the comparison is 16.8 km² wide. As the Autoline feature was used, no line planning was created prior to the survey. A total of 62 lines were surveyed.



▲ Bathymetric map with overlayed acquisition lines (white) for 2022

The mean overlapping on the area was set to 10%.

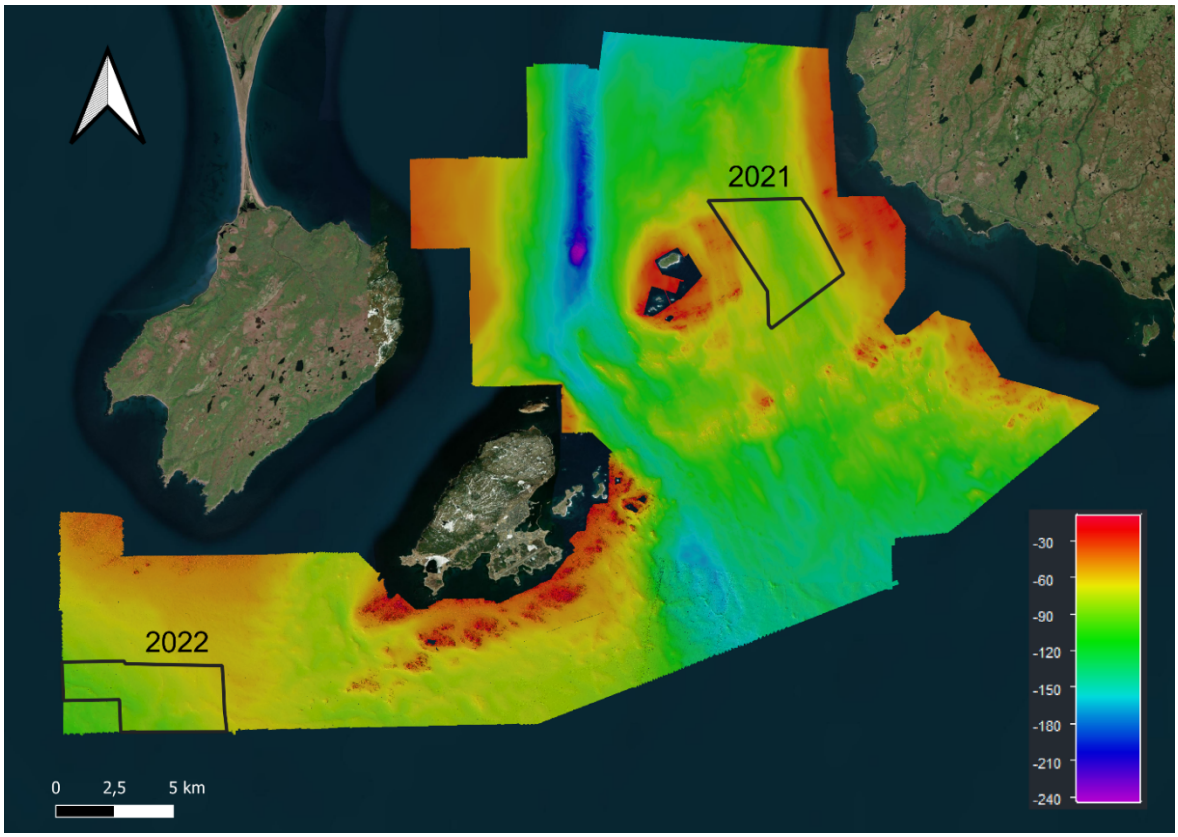
As for the 2021 zone, and for the same reasons, the exact survey time was calculated using trackplot logfiles.

The area survey was spread over 3 days. The figure below displays the 3 days trackplot with a position acquired every second.

The acquisition time is 14 hours and 19 minutes. No time was spent working on the line planning, nor on running infill lines.

5.3. RESULTS

The figure below displays both areas of interest.



▲ Combined bathymetric result for 2021 and 2022

The two areas represent the same surface, but despite operators efforts in optimizing the acquisition for the 2021 survey area, the 2022 survey was done 2 hours and 15 minutes faster. Considering the planning & re-planning time of 59 minutes for the 2021 survey area, the 2022 survey was done 3 hours faster.

The table below summarizes the time gained by using the Autoline feature on DriX.

area	Survey preparation	On site replanning	Survey mainline time	Survey Infills	Mean overlapping per line	Overall time (survey)	Gain during operation	Gain operation planning
2021	35min	24min	16h19	18min	24%	17h46	NA	NA
2022	8min	0 min	14h04	0 min	13%	14h29	17.33%	19.16%

▲ Result table of the comparison between 2021 and 2022

Conclusion

Comparing the 2021 and 2022 survey using the Autoline feature shows that the overall gain is close to 20%, when considering the overall workflow from line planning to survey execution.

Data analysis shows a mean overlapping of 24% in 2021 per line, compared to 13% in 2022. If the overlapping using conventional lines planning can be improved, the depth uncertainty makes it difficult to optimize due to the risk in creating infills.

The Autolineanalysis shows an overlapping of 13%, which is 3% more that the requested overlapping. This is explained by the conservative algorithm of the Autosurvey that will increase overlapping to maintain straighter lines when faced with depth variations.

In Autolinemode, decreasing the requested overlapping to 5% would have provided an additional 8% operational gain on the area, compared to 2021.

Finally, the Autoline reduces human dependency by automatically optimizing the survey plan during the survey execution based on high level survey objectives. It reduces the cognitive load on the operator who would otherwise need to constantly monitor the swath coverage and optimize the line plan during the course of the operation. The reduction of cognitive load leads to increased operational safety and reduces the risks of human error that could impact the overall operation efficiency.

The 2022 operation demonstrated significant operational gain during the survey with an operating time reduced by 20-30% compared to using the legacy method.

Combining DriX unique characteristics with its new advanced autonomy feature like the 'Autoline' raises survey efficiency to a new level with demonstrated efficiency gains.