



OPTIMISE OPERABILITY AND REDUCE DREDGING COSTS 20-50% WITH NONLINEAR CHANNEL OPTIMISATION SIMULATOR (NCOS)

The expert in **WATER ENVIRONMENTS**



The continuing surge in commercial vessel sizes is putting increasing pressures on the world's port authorities to adopt effective expansion strategies to ensure that their asset is able to meet growing capacity demands. Among the key challenges is to assure that effective strategic and operational measures are adopted to guarantee safe and efficient traffic through the shipping channel while also accommodating the demands of the commercial shipping industry. Channel capacity expansion projects usually involve the consideration of extensive dredging which introduces considerable constraints with respect to cost and environmental impacts.

NEXT GENERATION SOFTWARE SOLUTION

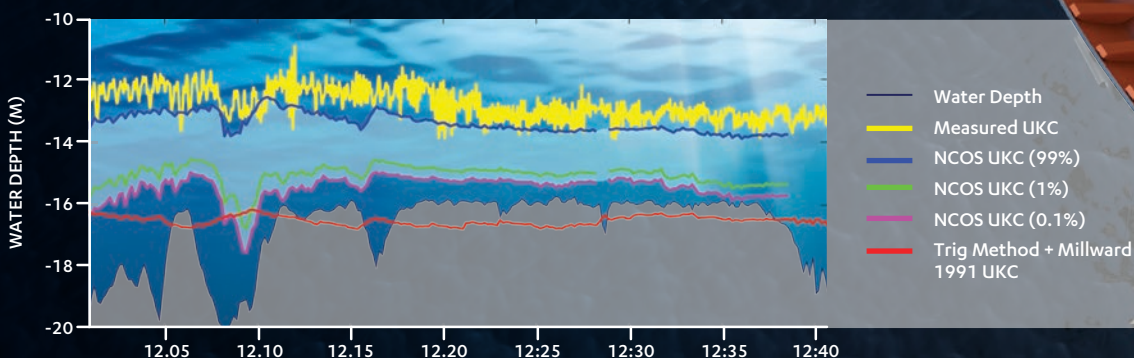
DHI and FORCE Technology have together developed a cutting-edge software package for quantifying and optimising channel operability, which sets a new industry standard for how accurately vessel under keel clearance (UKC) predictions can be incorporated effectively into the design and day-to-day operational management of navigational channels in some of the world's most complex waterways.

The software package is called Nonlinear Channel Optimisation Simulator by DHI (NCOS) and has the following two core applications:

- Integrated channel capacity optimisation assessments incorporating full 3D physics-based vessel response dynamics and long-term dynamic time series of vessel traffic and accurate environmental conditions (tides, winds, waves).
- Operational forecasting and scheduling of safe UKC windows for depth constrained vessels incorporating full 3D vessel response of scheduled vessels and running 7-day forecasts of all governing environmental conditions (NCOS ONLINE).

NCOS provides one of the most comprehensive and accurate solutions for helping ports and waterway operators maximising operability while often significantly reducing capital dredging costs compared to using conventional methods. For strategic planning purposes, it provides a clear identification of all constricted parts of approach channel with respect to grounding risk and estimates associated dredge volumes required to meet target operability criteria. For operational channel management (NCOS ONLINE) it provides a fully web-based and highly accurate case-by-case prediction of vessel response and UKC requirements without any limitations to vessel classes, sizes or configurations.

NCOS provides a clear probabilistic prediction of UKC requirements through the entire channel, which makes the method straight forward to validate against full-scale UKC measurement (See figure below).



Predicted UKC profile for a large Container vessel inbound through the Northwest Channel in the Port of Brisbane compared to full-scale UKC measurements.



NCOS VS CONVENTIONAL METHODS

The framework behind NCOS is best classified as a probabilistic design method for vertical channel design as described in PIANC (2014). NCOS utilises recent advances in High-Performance Computing (HPC) to maximise the accuracy of vessel UKC response while incorporating long-term variations in hydrodynamics and wave conditions along the shipping channel. The impact on channel capacity and UKC caused by temporal and spatial variations in waves and water levels through the channel is handled deterministically using a long-term (years) modelled dataset using MIKE Powered by DHI's world leading water modelling software.

The channel bathymetry and surrounding areas are represented by a high-resolution flexible computational mesh. Full 3D vessel response in each time step is handled stochastically using the detailed seakeeping engine S-OMEGA, which was until recently used exclusively in the high-end Full Bridge Ship Simulator SIMFLEX4 by FORCE Technology.

The table below presents a brief technical overview of how NCOS compares to most conventional methods for navigational channel optimisation¹.

BENCHMARK	NCOS	CONVENTIONAL METHODS
Wave induced vessel motions (UKC)	Uses a full 3D boundary element method that implicitly accounts for the forward speed and water depth. Same level of accuracy as high-end full bridge simulators.	Uses simplified 2D strip theory or empirical equations, which are less accurate. Often uses simplified methods for accounting, for forward speed and water depth.
Squat (UKC)	Covers most formulations used by full bridge simulators. Accounts for spatially varying levels of channel confinement.	Covers most formulations used by full bridge simulators. Does not always account for spatially varying levels of channel confinement.
Wind and turning induced heel (UKC)	Obtained from empirical equations or when required based on full force balance calculation.	Most often obtained from empirical equations.
Influence of environmental conditions (UKC)	Uses high-resolution spatially and temporally varying tide, current, wind and wave fields covering the entire channel.	Often relies on extensive instrumentation for providing in-situ measured time-series of water levels, wind and wave conditions at discrete points.
Compatibility with Full Bridge Simulators	Vessel wave response engine identical to SIMFLEX4 by FORCE Technology. Easy to assess threshold safety criteria in Full Mission.	Vessel response most often resolved too simplistically for direct comparison.
Risk Management	Provides the most accurate assessment of vessel response and UKC. Accounts for the limited duration a vessel is present in each sea state during transit Clear distinction between probabilistic vessel UKC response and applied safety factors.	Often does not account for the limited duration a vessel is present in each sea-state during transit. Often unclear origin of inbuilt safety factors in methods based purely on empirical.
Channel Capacity Assessment	Detailed quantification of dynamic weather and tidal constricted operability windows. Targeted identification of channel bottlenecks. Quantitative assessments of dredge volume requirements versus operability targets Includes any vessel class, configuration and size	Sometimes based on a limited matrix of worst-case environmental conditions. UKC calculations are less accurate and require large levels of safety margins to be applicable often leading to larger dredge volume estimates. Some methods only support a limited range of vessel classes, configurations and sizes.
Operational Forecasting	Detailed 7-day forecasts of environmental conditions. Suitable for any vessel class, configuration and size Web-based interface allowing for dynamic scheduling and viewing by operators and stakeholders with the internet	UKC calculations are less accurate and require larger levels of safety margins to be applicable often leading to less and shorter predicted operational windows. Does not always account for dynamic changes in wave conditions through the transit. Sometimes carried out off-site or based on simplistic static operability guidelines

REDUCING DREDGING COSTS 20-50%

By choosing NCOS, port operators are guaranteed one of the most accurate and comprehensive solution frameworks for channel optimisation. In most cases, this removes the need for unwarranted high levels of conservatism with regards to channel deepening and can reduce dredging requirements by as much as 20-50%.

REFERENCES

PIANC (2014), Report 121 – 2014, Harbour Approach Channels Design Guidelines.



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